THE

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"ELECTRICAL REVIEW."

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THE

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TUBE RAILWAYS AND COMPULSORY PURCHASE.

A CASE has recently been heard in the Court of Appeal, which would seem to show that the law of compensation presses somewhat harshly upon tube railway companies in cases where their workings in some degree affect, but in which they do not actually take over, property on the surface. It seems to involve the proposition that the Court will recognise a claim which is based upon the prospective depreciation which may arise from vibration.

It appears that a portion of the line and a station belonging to the City & South London Railway was to be situated beneath, or in the immediate neighbourhood of, the Church of St. Mary Woolnoth.

The company's Act of 1893 provided that "the amount of purchase money or compensation to be paid by the company for the portion of so much of the surface as is not occupied by the church as shall be required by them and for the sub-soil and crypt, and for temporary occupation of the church, and all other matters of difference were to be determined by an arbitrator, who, in assessing the amount to be paid by the company, was to take into consideration the additional liabilities and expenses entailed on them by the preservation of the church."

In 1897 the company gave notice of an intention to purchase some of the land round the church, and to take an easement under the rest, and to make temporary use of the whole of the surface and buildings. They excavated beneath the church, but so shored it up that no damage was done to the building. The question then arose as to the basis upon which the compensation was to be assessed. Three bases were suggested, namely—(1) that the land acquired was merely the site of a church which could never be used for any other purpose; (2) that, although the lands were then the site of a church, they might under some Act of Parliament or under a scheme under the Union of Benefices Act, 1860, or, otherwise, at some future time cease to be the site of a church and become available for the building of business premises, and that the arbitrator might draw his own conclusion as to when that time would be likely to arrive; or (3) upon the basis that the site of the church and the rest of the land could be made immediately available for the erection of buildings other than a church. As a matter of fact, a scheme was evolved in 1899 under which the church was to be pulled down, and the site, which is of great value, might be used for the erection of other buildings. The arbitrator assessed the price which the railway would have to pay on basis (1) at £90,628; on basis (2) at £136,421; and on basis (3) at £143,548. He left it for the Court to say which of the three bases should be adopted, and Mr. Justice Wright found that the company were liable to pay £136,421. On appeal, the Court of Appeal affirmed this

decision. Lord Justice Vaughan-Williams, in the course of his judgment said:—"It seems plain that the effect of the Union of Benefices Act, 1860, was that, upon a scheme being instituted by the Bishop, the site of a church can be sold in such manner that the purchaser is under no restrictions in the user of it. It is said that the railway company's private Act contains a provision that the church shall stand in perpetuity, and that it is therefore impossible to deal with the church under the Union of Benefices Act. I cannot find any such provision in the special Act. It provides that the company are not to acquire the site of the church, but only the adjacent lands and the subsoil, and the foundations of the crypt. It does not follow, because the railway company are not allowed to pull the church down, that therefore the site can never be dealt with under the Union of Benefices Act." We respectfully agree that there was no express provision in the company's Act to the effect that the church was never to be taken down; but it is quite clear that this was within the contemplation of the parties, inasmuch as the company had to take steps to support the surface, and the arbitrator in assessing the purchase price was asked to take into consideration the additional liabilities and expenses entailed on the company in the preservation of the church. Further, so long as a proper measure of support was given to the surface, it is difficult to see why the railway company should be compelled to pay an additional £50,000 because the site of the church might at some future time be used for business purposes. Again, how far does the fact that the railway runs beneath this particular piece of land diminish its selling value for business purposes? It is this loss which the tube company have now been called upon to bear, and for our part we fail to see how it can have assumed such gigantic proportions.

If it is a mere question of vibration, the City and South London Railway Company, who have always been exceptionally free from troublesome complaints under this head, are certainly coming off worse than the promoters of some other tubes, who have hitherto been protected from claims of this kind.

We assume, however, that the particular works under the church were very close to the surface, and that compensation was based upon this footing. Tube railway companies have so many difficulties to contend with in their attempts to carry out works for the public benefit, that we regret to observe that the Courts, in interpreting the present law of compensation, seem compelled to increase those obstacles.

The Energy of Radium.

A LIVELY controversy has been going on in the *Times* about the origin of the heat-energy continuously emitted by radium. Sir William Crookes proposed the theory that the higher temperature of radium was due to some mysterious property it possessed of absorbing the energy of those molecules of air which moved with higher velocities than the mean velocity of all the molecules. According to the kinetic theory of gases, the molecules of a mass of air move with very different velocities, some being higher than the mean and some lower. The absolute temperature of the air is proportional to the mean square of these velocities. Now, if radium had the property of selecting and absorbing the energy of the higher velocities only, its temperature would be higher than that of the surrounding air. A correspondent, "Ignoramus," argues against Sir William's hypothesis with forensic skill, maintaining that if the hypothesis were correct, the temperature of radium should be reduced when the air is rarefied; but experiment shows that it is not. Mr. Johnstone Stoney comes to the rescue of Sir William, but winds up by propounding quite a different theory of his own, in which there is nothing said about radium selecting the high speed molecules, but a great deal about the viscosity of gases and the molecules of radium not being able to penetrate through the molecules of air. But how all these circumstances account for the apparently inexhaustible supply of heat, which, according to the experiments of MM. Curie and Laborde, is to be obtained from radium, we fail to see. If radium absorbed the energy of high speed molecules of air, it would in time get saturated with these molecules and lose its property of emitting heat. If the heat is produced by the viscous friction between the particles thrown off by the radium and the molecules of air, whence comes the energy that projects the particles from the radium? Meanwhile, as will be seen on a later page of this issue, Sir Oliver Lodge, far from being surprised at the existence of such radiation, only wonders "why it is not more notorious"!

Trade with South Africa.

FOR some weeks past we have been publishing important news from a special correspondent in Johannesburg regarding the development and progress of electrical undertakings in South Africa. We have introduced this new feature because it is imperative that electrical engineering firms in this country should be kept well-informed as to the course of events if they are to fill their proper place in the competition for electrical business. We venture to believe that this week's instalment of news will be found especially interesting, and we would single out as of more far-reaching importance than all other points, the counsel and warnings which the Board of Trade Commissioner, Mr. Birchenough, vouchsafes to the British manufacturer. He advises that the new markets be cultivated in the same way that British traders have secured a footing in the older ones; there is no argument in favour of "cheapness" in this advice. But he also speaks very plainly about certain weak places in British electrical engineering, especially in its relation to South Africa. Our manufacturers will be wise if they seriously consider what he says.

Premium System of Labour Remuneration.

THE old idea of payment of a workman is that based on the time he worked; so many hours of work and so much pay. The workman was supposed to do his reasonable best, and if we are to trust tradition and the evidences in the shape of work done that have come down from past ages, he did good work, and presumably the best man got the best pay. Then came the trades union idea of equal payment all round: at least, that is what the trades union minimum demand succeeded, intentionally or otherwise, in accomplishing. Piece work has no doubt been on the stage in various forms for many years. It was, of course, based on the fact that, by having the opportunity of earning more, a workman would do more work in a given time. Early piece-work prices were based on the supposition that, by reasonable attention to duty, a man could do, perhaps, 20 or 25 per cent. more work in a given time, and piece prices being fixed according to that supposition, were usually fixed far too high. Men found they could easily do double, treble, or even fourfold what they had accomplished, and began to earn "too much money." This phrase is, no doubt, familiar to many. Who

was to blame for the fixing of the rate too high? The man whose previous idleness had set the ideal pace for day work? or the master whose ignorance of what was possible had led him to believe that the man was working not far from his honest speed?

After these high prices came the cutting of rates, which was carried on until any further cut resulted in the man being unable to earn even time and quarter. This was the so-called bed rock price to reach which successive cuts had to be made through a great thickness of ill-feeling. This cutting of rates showed the men that they would not be allowed to earn more than a certain sum—call it time and quarter. Hence arose the ca-canny system of working at piece rates. The man would not exert himself to earn more than the extra quarter, and it is probable that much piece work has been done at rates far more costly than the slowest of day work. It all hinges on ignorance of possibilities. It is usual to believe that in America piece working has been better ordered than here, but anyone who reads the American papers will soon realise that the same troubles exist there as here, and evidence of this is apparent in the so-called premium systems of payment, which at present attract a good deal of attention here also. The question was recently dealt with by Mr. J. Ashford, in a paper before the Manchester Association of Engineers. As with all advocates of premium systems he assumed that piece work rates were inevitably fixed on a wrong basis, and premium rates were started on a proper basis. Mr. Naysmith attacked this weak point, and further pointed out that no system could be a success unless the rate once fixed was rigidly adhered to, and, of course, this is the crux of the whole matter. He deprecated the idea so strongly held that the workman must not be allowed to earn more than 1¼ time. The whole discussion practically emphasised the importance of rate fixing, and of liberality to the worker. It is because of this difficulty that a system of profit-sharing should really work so much better. Unfortunately, the average workman does not take kindly to profit-sharing, but it ought to be possible where so many concerns are limited and their profits are known.

The Rowan system is as follows:—Men are paid regular day wages. When given a piece of work to do there is a time fixed for the doing of it. If the man takes a longer time he simply gets paid his day wages, but if he does it in less time he receives a percentage of such saved time. Thus, if he does a given piece of work in three-fourths the allotted time, thereby saving 25 per cent. of the time, he is paid 25 per cent. extra. By this system no man can possibly double his day rate. Other systems pay the men 30 or 50 per cent. only of the economised time. All are based on the idea of protecting the employer from his own fear of having to pay a man too much. A mistake is less liable to result in paying very high wages, and there is so much less temptation to cut the rates.

But the premium system is open to much the same difficulties as the piece system in fixing rates, especially in shops where the work is not absolutely standard. Things like high-speed engines have a certain set of fixed details. Large marine engines are not so fixed.

Properly to work any system, demands much observation and clerical work, for every machine tool must be analysed very closely for performance. The new tool steels must be a thorn in the side of an established system, for they may put up the output possibilities of some machines and fail to help the weaker machines. One thing is certain, machine tools have for years degenerated into slow creeping things, to watch one at work being sufficient to worry any man of active mind. Only a slow lethargic man could possibly attend to such a tool. We seem now to have taken a step forward which will place the removal of iron and steel more on a par with the hum and bustle of the saw mill.

WIRELESS TELEGRAPHY IN THE UNITED STATES.

By E. GUARINI.

(*Continued from page* 644.)

In 1899 Mr. A. F. Collins, the distinguished "wireless publicist" of the United States, patented two receivers for wireless telegraphy worked by coherers, in which de-cohesion was obtained by a magnetic effect. In one of these (fig. 5)

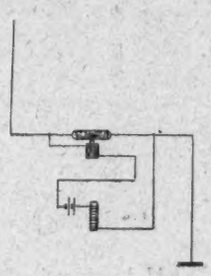


Fig. 5.

the magnetic filings of the coherer—which was placed in circuit with a telephone and a battery and connected at one end to earth, and at the other, to the antenna—were attracted, on a little disc of magnetic metal, by an electro-magnet in series with the winding of the telephone. In the other (fig. 6) the telephone was worked by a battery, the circuit

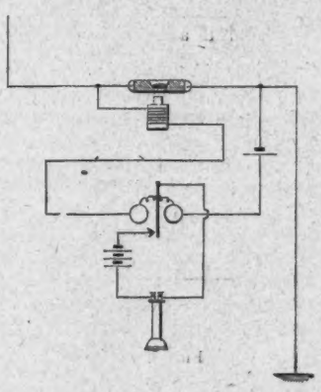


Fig. 6.

of which was closed by the armature of a relay placed in circuit with the coherer and the de-cohering electro-magnet.

At present, if we do not reckon the experiments made by Marconi in 1899, in communicating between America and the United States Navy, and from 1901 to 1903 in communication across the Atlantic, all of which experiments are familiar to readers of the Electrical Review, we find that there are, in the United States, three "wireless" systems:—(1) The Collins wireless telephone; (2) Prof. Fessenden's wireless telegraph; (3) The Lee-de Forest wireless telegraph.

Before discussing these systems, we will say a few words with regard to the experiments made by Prof. Gore and Prof. Hammel, in 1900, with a view to sending signals by so-called "wireless" telegraphy to trains in motion.

In principle their system consists in arranging upon the train a coherer (fig. 7), and influencing it by the extra currents produced in an ordinary telegraph line extending along the track, by the opening and closing of the current.

It is known that a coherer can be influenced by ringing a bell in its vicinity. In fact, this is the method used by wireless telegraph operators for testing the sensitiveness of their coherers in comparison with a standard battery and bell. By using a bell with great self-induction, worked by a single Leclanché element of the medium type, the writer has been able to influence a very sensitive Blondel coherer constituted of gold filings at distances amounting to

6 metres. Moreover, the distance increases with the electromotive force of the battery, and the intensity of the current which is rendered intermittent.

In the Gore-Hammel system, the transmitting circuit is simply closed by the earth. The inventors found it advantageous to introduce into the telegraphic circuit a self-induction, a bell, for instance. If necessary, the coherer

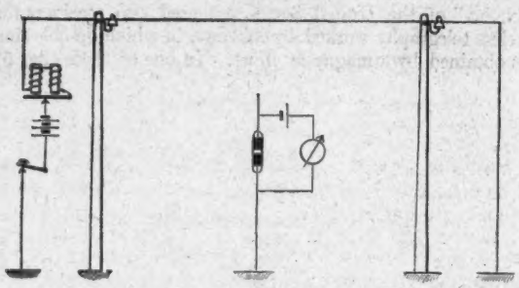


Fig. 7.

placed upon the train could, by using in the telegraph line a current of sufficient intensity and pressure, be worked without any other preparation. But experience showed that it was better to add an antenna to the coherer, probably with a view to diminishing the power of the battery to be introduced into the telegraphic circuit. The effects are still further improved if the other terminal of the coherer is connected to earth. This arrangement—we have seen it in the Edison-Gilliland system—can be realised without any trouble, by using the axle which is in communication with the rails through the medium of the wheels. The effect is appreciably increased if a helix is connected with the antenna (fig. 8).

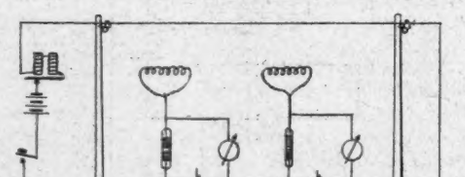


Fig. 8.

In the course of their experiments, Messrs. Gore and Hammel found that their coherer was influenced when the antenna made a right angle with the telegraph line. Mr. Gore remarked in the columns of the *Electrical World* that the results obtained seemed due to the same cause as that which affects a coherer when a sudden change of potential is produced in an insulated conductor placed near the extremity of the antenna; in consequence of the electrostatic induction one of the terminals of the coherer has its potential changed, which brings about the working of the apparatus. From these experiments and others that it would take too long to describe, Mr. Gore concluded that long-distance wireless telegraphy is an electrostatic effect rather than an effect of Hertzian waves. An oscillatory electrostatic force between ether combined with matter (the earth) and the freer ether of the surface of the earth, produces waves that are propagated around the earth. The better the earth conductor, the greater will be the electrostatic effect; the more flexible the surface of the earth, the less will the waves be distorted and deflected. It is these conditions, concludes Mr. Gore, that have been found favourable to the transmission of signals by wireless telegraphy.

We will now consider the wireless systems mentioned above.

The system of wireless telephony, invented by Mr. Collins, has for its starting point the statement made by its inventor that as sound is propagated better through a medium more dense than air, water, for instance, so electro-magnetic waves are propagated better in the denser ether, *i.e.*, the ether connected with the earth.

The Collins system (fig. 9) consists in raising the pressure of the telephonic current, in charging condensers and discharging them into the earth, through which

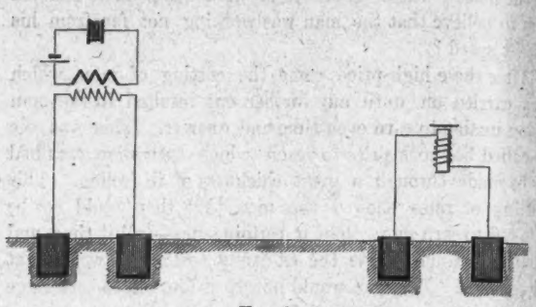


Fig. 9.

the waves are propagated, and so influencing a telephone connected with condensers sunk in the earth, which, in their turn, become charged, and then are discharged through the winding of the telephone. The distance of transmission was successively 200 ft., 1 mile, and 3 miles in open country. This system might be of considerable service under conditions suited to wireless telegraphy, especially at sea, where it might prevent collisions between vessels.

(*To be continued.*)

ELECTRIC SAFETY FUSES.

Safety fuses on high and low-tension systems of electric lighting and power have in recent years undergone a complete change in design to suit the various purposes for which they are required. Considerable ingenuity has been displayed, and the efforts of those engineers who have ably entered into the important modifications to ensure safety and reliability of action, seem to have met with considerable success. To prevent an outbreak of fire, the destruction of costly apparatus, the total collapse of a large electric service, and even to safely protect life itself, by putting in circuit a metal strip or wire, which shall fuse at the right moment with an excess current of pre-determined strength; to so safely guard the "fuse" and its connections that no person shall be injured through shock or the spattering of molten metal; and to instantly smother any "arcing" at the time of rupture, involves much thought, experimental work, and pecuniary outlay.

The name "safety-fuse" has become a household word, yet how few realise the labour and money that have been expended to obtain efficient and safe devices for all classes of circuits, from supply mains having pressures of hundreds and even thousands of volts, to circuits bearing large or small currents at comparatively small pressures! The old open type of fuse, that which was exposed to view without protection of any kind, has very properly been entirely abandoned, hence our attention will be confined to the enclosed type of fuse.

Engineers have not yet adopted a uniform metal for general use, copper, zinc, tin, aluminium and several kinds of alloys being employed according to individual ideas of their fitness for particular purposes. The main object is to so gauge the size and shape of a fuse, whatever it be, that while delivering normal current to the circuit, no dangerous heat shall be generated, yet when the rated fusing current is reached, its destruction shall be certain without damaging either its own cover or anything else.

According to an able writer on the subject, Mr. Joseph Sachs, fuses should have "high electrical conductivity, a low melting point, a suitable heat radiating surface, be inoxidisable, a low specific heat or a high specific heat, according to whether the fuse is to be sensitive to load conditions or to require inertia," * and various other properties; but as no known metal can fulfil all the conditions suggested,

* *Journal of Franklin Institute*, Pennsylvania, Vol. clv., No. 1, January, 1903.

other means must be employed to aid these essential functions. The temperature of a conductor in which heat is generated depends partly upon the cross-section and partly upon the extent of the radiating surface. The smaller the section of the conductor the less is the heat conducted away; the smaller the radiating surface the more is the radiation impeded. Both the concentration of the heat and the hindering of the radiation produce an augmentation of temperature.

Now, for a fuse to be effective, the smallest possible mass consistent with safe carrying capacity for the work required is advisable, because it is clear that a reduced mass must necessarily minimise the risk of serious arcing when the fuse "blows." Metals of high conductivity are therefore the most suitable to use in this respect, but they unfortunately have a high melting point.

To some extent this apparent objection is an advantage, inasmuch that the molecular structure of the fuse would remain more uniform from the effects of a prolonged current, while soft metals such as pure tin and certain alloys would in course of time so change their structure as to alter the rated characteristic of the fuse. We believe that high conductivity fuses of inoxidisable metal, properly proportioned as to current-capacity, and well flattened out to promote satisfactory heat radiation with the minimum cross-section, are superior to those of a lower melting point in their behaviour as fuses.

Aluminium is regarded by some engineers as a first-class fuse for currents, say, from 20 to 100 amperes. When the point of fusion is attained by gradually increasing the current through a wire of aluminium, the element suddenly oxidises to alumina, becomes for a moment vividly incandescent, and then quietly drops as a white powder. An instantaneous rush of current greater than its carrying capacity does not cause violent spattering of molten metal in all directions like some other metals of high conductivity. Instead of employing one strip for large currents, two or more of the same rated capacity in parallel are often preferred. For small fuses up to about 3 amperes platinoid wire of No. 36 S.W.G., single and in multiple, according to the strength of current, has been employed with good results. Soft alloy or pure tin fuses in such cases have frequently been found to cause trouble through early failure after renewal, owing to the attendant damaging the fuse wire by screwing down the binding screw too hard upon it. Platinoid is a tough metal, and the man can, therefore, feel when the screw end or terminal nut presses against the wire; he can also tighten up securely without fear of seriously injuring the fuse at the point of contact.

On important installations well known to us, aluminium and platinoid have been very successfully employed as above for several years past, and pure tin wire from 3 to 20 amperes; but our opinion is that the former metal could be equally well employed for every case exceeding 3 amperes. Of course, the increased expense is a factor for consideration; still, greater efficiency and less risk of arcing are worth something. Copper is, to our mind, not such a safe metal to use for heavy work as aluminium, and on no account should it be adopted for light work.

We have seen numerous experiments conducted with wires of different metals, all of the same gauge and length, which taught us some valuable lessons. They comprised four series of tests:—

1. To slowly and evenly raise the current in the separate wires until the first sign of redness appeared, the eyes having previously been made extremely sensitive to light by the observer looking into a dark receptacle containing the wire under test. This wire was in series with a sensitive reflecting galvanometer, and therefore as the current increased, the spot of light slowly traversed the scale; hence at any moment readings could be taken, and converted into true current values. The regulating resistance consisted of a disc of wood about 12 in. diameter with square cut concentric grooves on its upper surface. These grooves were made to run into each other spirally, and were afterwards filled with mercury. The resistance could be steadily varied by means of a movable conductor. Two operators were engaged; one, whose eyes were excluded from daylight, looked into a small box containing the test wire, and at the same time slowly manipulated the movable conductor in the mercury, while the other operator closely followed up the galvanometer readings. When the former saw the first glow of redness on the wire he called out for the latter to take the scale reading.

2. To ascertain the current which first produced visible redness of the wires in daylight.

3. To ascertain the strength of current which fused the wires; and

4. To short-circuit each wire examined, with a definite voltage of excessive value, and to watch the effect of the molten particles when the wire burst; even the distance the particles were thrown was measured, and their burning effects noticed. The scintillations of iron were pleasant to look at, but exceedingly dangerous. Copper threw the particles several feet away. No. 18 S.W.G. wire was used in each case of sudden fusion, and the length between the terminals was 2½ in. The melted particles of copper were very dangerous in so far as their burning effects were witnessed. We also remember several interesting experiments that were made with No. 36 bare copper wire of high conductivity, which showed (*a*) that if stretched tightly between two fixed points, and the current gradually and smoothly raised in it, fusion would take place with less current than when the cold wire was slack; (*b*) that with the tightly stretched wire an average current of 10 amperes was required to fuse it, while a current of 5 amperes at the same pressure would instantly break it if suddenly applied.

The several devices recently introduced to render fuses at the moment of rupture free from destructive effects have gained well-deserved praise from the majority of engineers. Even the small protective boxes for low pressure installations have been so modified and improved of late years, that where previously it was possible to completely shatter the porcelain base and cover, which contained a fuse wire of only 72 mils. diameter, by causing a dead short circuit to occur, now, under similar conditions, such violent burstings are entirely prevented simply by adding a dividing bridge of porcelain to the base, through which the fuse wire passes from one connection to the other. It is, however, when we examine the various fuses of higher capacity, such as Partridge's, Mordey's, Moy's, Sachs's, Ferranti's, the Hall-Fuller, Bates's, the General Electric, Peard, &c., that we more forcibly realise the vast improvements made to suit high and low pressure safety requirements. Some inventors prefer to wholly or partially surround the fuse with powdered substances inside a fibre or glass tube; to enclose the fuse wire in a covering of asbestos; to choke the arc, on the circuit being interrupted, by drawing the fuse into a bath of oil; to introduce a "'Sparklet' for the joint purposes of freezing, choking and blowing out the arc" (*Vide* ELECTRICAL REVIEW, No. 1,284, page 40); and to curve a copper fuse strip over two separated blocks of insulating material, between which a non-metallic screen is caused by a spring to press against the centre and narrowed part of the curved strip, so that when the fuse "blows," the screen immediately shoots up between the ends and stops all risk of an arc forming.

The last idea reminds us of the old Cockburn fuse, which had a pellet of lead hung on the fuse wire midway between its extremities. This method, however, would not suit the present-day applications of electrical engineering. Mr. Partridge used tubular fuses on high pressure systems before he designed his ingenious "Sparklet" fuse, but we do not know whether anyone has ever tried the effect of filling tubular fuses with an insulating substance which will either chemically or mechanically prevent arcing, or other dangerous effects, when the fuse breaks. We shall be glad to hear if any attempts have been made in this direction, or to learn the result of any experiments that may be conducted.

Apart from the actual fuse and its arc-damping environment, much care has been exercised to safely enclose all connections, and thus to prevent persons from being injured through shock by contact with high-pressure parts of the circuit, or from an accidental short circuit taking place while a fuse is being renewed. We hold that there should not be the slightest chance of the fuse on each main being exposed simultaneously while the circuit is alive. When one box is open for attention, the other box ought to be absolutely closed by an automatic interlocking arrangement, or the boxes should be so far apart that a man cannot easily get a shock or produce a short circuit. These important

points have been well thought out in some designs which have come under our notice. As regards the pros and cons of "filling materials" surrounding the encased fuse, and their characteristic properties for the purpose, we must, for the present, leave them alone.

THE USE OF INDEPENDENT CRANE CONVEYORS FOR COAL SUPPLY IN CENTRAL STATIONS.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

Until recently it has not been considered necessary to equip electricity stations with coal and ash conveyors, and the consequence is that most of the stations in this country are without these very useful appliances. As more and more extension plant is laid down, the want of some convenient means of dealing with the fuel supply begins to make itself felt. Unfortunately, buildings which are already erected do not, as a rule, lend themselves to the installation of a complete conveyor plant with overhead hoppers for coal storage and an underground chamber for removal of ashes on the continuous hopper or bucket system, or the screw conveyor working in a trough. For a small station, also, the question of expense is important, and it may not pay to lay down an elaborate plant. For such cases the writer is of opinion that there is a future for the small independent crane conveyor, such as has been used for carrying luggage about railway stations at Manchester, York, &c. The crane conveyor is actuated by an operator who rides with it, and it runs on overhead steel girders or rails. Consequently it may be taken in and out, round curves of comparatively small radius, and into out-of-the-way corners which could not be served by the ordinary continuous conveyors, because the latter must always work in a straight line.

The crane conveyor simply consists of a small locomotive and crane combined, the motor of which is supplied with current from the girder rails on which it runs, or else from a pair of trolley wires fixed between the upper and lower flanges of the rolled steel joist, on the lower flanges of which it is supported.

A plant of the two-rail type has been in operation at the Brompton electricity works for some considerable time with great success. The Maidstone electricity station has also adopted this system. At the Brompton station the crane conveyor will lift a gross load of 16 cwt. at a speed of 26 ft. per minute, and will convey it at a speed of 700 ft, per minute. The electric motor is of the Mather & Platt steel-clad type, arranged to take current at two voltages. At the lower pressure the motor gives 3 B.H.P. at 1,200 revolutions per minute, and at the higher pressure 1½ B.H.P. at 1,800 revolutions per minute. The alteration from hoisting to travelling is effected by means of a mechanical friction clutch worked by a lever by the operator. The rails are bulb-headed flanged rails, insulated from the hanging bracket, and the wheels of the crane conveyor are carefully insulated from the main body of the apparatus.

A great advantage of this electric conveyor crane is that it may be utilised for carrying other things besides coal; thus, for example, a deviation may be made into the engine house, and repair parts or extension plant may be quickly taken in and out. It can also be utilised for delivering oil and other stores, whereas the continuous running conveyor must be used for coal and nothing else.

One very important advantage which the independent electric crane conveyor has over the continuous running conveyor lies in the fact that wherever it may be delivering coal the whole of the continuous conveyor must run, and consequently its all-day efficiency is very low. Now, with the independent crane conveyor electric energy is only used when it is actually doing work, and then only in proportion to the distance travelled; thus, when delivering coal to the nearest boiler the energy required is a small fraction of that necessary to deliver to the boiler furthest away from the canal or other source of supply.

Another point favourable to the independent crane conveyor is that if the load is always in one direction the I section, or girder rails, may be laid with an inclination in that direction, so that the actual current required when the conveyor is travelling loaded is only sufficient to overcome friction. It may be mentioned that the maximum current is used when making a direct lift; thus, when raising 15 cwt. at a speed of 26 ft. a minute, the current taken at starting is 40 amperes at 100 volts, but this quickly decreases as the hoisting proceeds.

Regarding the size of such an independent crane conveyor, it may be mentioned that to lift 15 cwts. at 26 ft. a minute, and travel with it at 700 ft. per minute or 8 miles an hour, the apparatus as made by Messrs. Mather & Platt measures 4 ft. long by 21 in. wide and 4 ft. 6 in. deep. The total weight when loaded is 30 cwt., thus:—

Conveyor	13 cwt.
Bar and hook	1 „
Operator	1 „
Load	15 „
	30 cwt.

Such a conveyor costs £195, and the price per foot run of I-joist, with hangers and supports, is from 5s. to 7s. 6d.

THE INSTITUTION OF ELECTRICAL ENGINEERS IN ITALY.

(*Continued from page* 651.)

[Errata.—On p. 624, col. 2, line 1, for "Sinati" read "Linati."

On pp. 650 and 651, in the account of the ceremony at the tomb, for "Cav. Linati, Mayor of Como," read "Cav. Franchi, Mayor of Camnago-Volta." We greatly regret that this error occurred.]

At 8 a.m. on Monday, April 6th, the Electrical Engineers left Como for Milan. On their arrival at the Central Station, Milan, they immediately boarded an electric train which was in waiting, consisting of one motor-car and three trailers, and started soon after 9 a.m. to traverse the whole length of the Milan—Varese line which is at present electrically operated. A description of this railway, the power station, &c., appears elsewhere in this issue, from which it will be seen that the system of working is practically the same as is already in operation on several short railways in this country, and is now being applied to longer stretches of line. The railway, therefore, unlike the Valtellina line, had not the charm of novelty, but nevertheless it was inspected with keen interest and appreciation. The high speeds attained, combined with the smoothness of the motion, were noteworthy. To us there is an air of *comme il faut* about an electrically-operated railway system which is lacking from a line operated by steam, or rather, in the first instance, by flue gases, which are very well at a power station, but do not tend to cleanliness and comfort when distributed over the passengers. The steam-hauled train appears to be crude and primitive in comparison.

The first notable event on the journey was our arrival at Porto Ceresio, where the visitors disembarked for the purpose of admiring (and, of course, photographing) Lake Lugano. The beauty of the view was unexcelled; the azure waters of the lake, dividing to right and left of a steep conical headland, at the foot of which nestled the village of Morcate, formed a picture in the morning sunshine that alone amply repaid the journey.

Re-embarking, the party returned as far as the first station, Bisuschio, where they inspected the sub-station. Here there is a large battery, working in conjunction with an automatically-regulated booster of the Thury type; the booster is provided with an automatic attachment to cut it out in case of an accident to the rotary whereby current would come back from the line, tending to run the booster up to an excessive speed.

After this the visitors were conveyed by train to Varese, and were driven in carriages to the Grand Hotel in the suburbs, where an excellent lunch was provided by the Mediterranean Railway Co. and the Compagnie Thomson-Houston de la Mediterranée. There were present with the party Signor Kossuth, vice-president of the Mediterranean Railway Co., Cavalieri Mandolini and Tremontani, and many other engineers associated with the management, as well as Mr. Garfield, consulting engineer to the Thomson-

Houston Co., and Signor Ciarlo, engineer of the latter company. Signor Kossuth, who is the son of the famous Hungarian, addressed the assembly in English in the most cordial terms; a member of the Thomson-Houston Co. also spoke, and the President, Mr. R. Kaye Gray, made an appropriate reply.

Colonel Crompton proposed the health of our hosts, and eulogised their hospitality, while he emphasised the importance of the lessons to be learnt from the railway by British railway managers. Signor Kossuth, whose name was coupled with the toast, praised England as the mother of constitutional freedom, and Mr. Raworth afterwards toasted the Mediterranean Thomson-Houston Co.

The party then got under weigh again, and returned by train to Gallarate. From this point they were conveyed in carriages to Tornavento, a drive of about 9 miles; as there were nearly 200 members, including the Italian visitors, the procession of vehicles was protracted, if not imposing. The power station is situated on the River Ticino, and much speculation was aroused as to the reasons for building it so far from the railway, seeing that it is equipped with steam plant. An industrial canal, at present empty, passes close by the works; this was generally taken for a power aqueduct, and supposed to be intended for the projected hydro-electric power station. The generating plant is of the most modern type, supplied by the Mediterranean Thomson-Houston Co. and Messrs. Franco Tosi. A noticeable feature was that the engines were of the tandem compound type, with only one crank; two sets were at work at the time of our visit, and, as it happened, the cranks were in synchronism; we were assured, however, that this was merely a coincidence, and that the generators ran well in parallel when this condition was not observed.

The main switchboard is mounted on a high gallery, and is of the usual standard G.E. type, with ammeters and voltmeters of a very neat and compact pattern. The transmission lines are, of course, overhead, and the power is generated at 13,000 volts without transforming up. It was, indeed, noteworthy that in no case was the latter evolution adopted, though at Morbegno the pressure was no less than 20,000 volts; this fact speaks highly for the standard of insulation and reliability that has been attained, and for the advantages of the stationary armature.

Having completed their inspection of the power station, the visitors returned as they came to Gallarate, and there entrained for Milan.

Much disappointment was expressed on account of the party being widely dispersed at the different hotels in Milan; this, however, was unavoidable, owing to some understanding between the respective hotel managers, and, indeed, it was not to be expected that, at such a busy season, large parties could be accommodated at individual hotels for a few days only.

On Tuesday the 7th inst., the programme provided for a visit to Signor Gavazzi's silk works, at Merate, and the Paderno power station, which has become familiar to English readers.

As the silk manufacture is one of the most important industries of Lombardy, the first visit possessed a special interest of its own. The firm employs about 500 work-people, and there are installed over 300 looms, &c., each of which is driven by a small three-phase motor of about ¼ H.P. It appears that polyphase motors are quite suitable for this class of work, because the load is practically constant, and the power factor, if not high, is at a maximum. For other kinds of work, where the load is variable, direct-current motors are preferred, mainly on account of the power factor.

Various forms of gearing were in use—belt, spur and chain. The favourite appeared to be a short leather belt, which is readily adjusted, elastic, simple and inexpensive. On account of the delicacy of the material dealt with, it has been found necessary to adopt an elastic connection to prevent breakage of the threads when starting; this takes the shape of a spring suspension, the motor being hinged at one side, and supported by a spring on the other. We noticed, however, that in many cases the springs of belt-driven motors were out of use, part of the weight of the motor resting on the belt; doubtless the slip and elasticity of the belt are found to suffice in these instances. The advantages of the individual drive, such as freedom from long belts and shafting, with their attendant evils—oil, dirt, and danger, the avoidance of waste of power when part of the plant is at rest, the ease of control, &c., need not here be dwelt upon. It is open to question, however, whether it is generally advisable to carry out the principle of sub-division in its entirety when the individual motors must be of such small sizes, if only on the score of inefficiency. The group system, as a matter of fact, is used to some extent at this mill, small winders, &c., being driven from shafting.

The generating plant consists of two machines by Messrs. Gadda & Co., and one by Messrs. Brown, Boveri & Co., the latter driven direct by a compound Tosi engine. Part of the power is derived from the Paderno electricity works. The employés at this mill work rather long hours, from 6.10 to "18.45," according to the Italian reckoning—*i.e.*, 6.45 p.m.—making a net total of 11 hours per day. Children between 10 and 12 years old work eight hours. Needless to say, the mill is beautifully clean throughout, and is well lighted, while the roof is specially constructed to prevent dirt or moisture from falling on the materials in course of manufacture.

Leaving the silk works, the visitors were conducted to an open-air luncheon at Merate, provided by the Società Generale Italiana Edison di Elettricità. Here there were several informal speeches, which we have not recorded; we may, however, note that Mr. C. A. Baker, speaking in Italian, referred to the time when he was associated with the Italian Edison Co., in 1887; the Santa Radegonda power station was then the largest in Europe, and by its regular operation inspired the inhabitants of Milan with well-founded confidence in electric light and power. Due credit should be assigned to the company for its courage and enterprise at a time when electric lighting was still in the early stages of its development. The Edison system was introduced into Milan by the company, with underground mains, in 1881, long before any important undertaking of the kind had been started in London.

After lunch a drive of a few miles brought the party to the head works of the Paderno power canal, which runs for some distance alongside a canal designed by Leonardo da Vinci. Here a number of workmen were employed in carrying out extensive alterations, with a view to raising the level of the weir by about 1 metre, for the purpose of increasing the available power. The foundations of the work having proved untrustworthy, they were being strengthened from below the surface with the aid of compressed air.

From this point the visitors enjoyed a delightful walk along the valley of the Adda, to the power station. The latter is now completely filled with plant, there being seven 1,500-KW. generators built by Messrs. Brown, Boveri & Co., and driven by Messrs. Riva Monneret & Co.'s turbines. The head of water is 30 metres, and the canal is 1½ miles in length, largely in tunnels. The generators work at 14,000 volts, 42 cycles per second, and run at a speed of 180 revolutions per minute. The load on the station is very heavy and constant, practically the whole of the available power being utilised.

The armatures of the generators are stationary, but are carried on arms so that they can be rotated for inspection and repair; they can be divided on the normal horizontal plane without removing any of the coils. Some of the magnet wheels are driven through flexible couplings. There are two main switchboards, one for the generators, the other for the outgoing feeders; these are of the usual frame construction. The high-pressure switches are of the oil-break type, fixed overhead, and are so arranged that the oil vessel can be lowered away from the switch by means of screws and hand-wheels, exposing the metal parts. The main fuses are enclosed in compartments divided up with marble panels; as the fuses are apt to be blown to pieces, asbestos screens are suspended before them to prevent injury to passers-by. The bus-bars are divided into sections with fuses and couplings, and each alternator is provided with a large two-way switch, consisting of three sets of fixed contacts and a set of movable bridge-pieces pivoted in the middle—the whole looking like a set of fuses rather than a switch. The installation of lightning arresters in an upper room excited much interest; the Wurts system is used for the most part, and one or two other systems are on trial.

(To be continued.)

REVIEW.

The Law relating to Electric Lighting, Traction and Power. By John Shiress Will, K.C., Joint-Author of "Michael and Will on the Law relating to Gas and Water." Third Edition. 1903. London: Butterworth & Co. 25s.

Mr. Shiress Will's work on the law of electric lighting has been before the public since 1898, and has in the intervening years passed through two editions. This fact is in itself valuable testimony to the merit and usefulness of the book, and on the present occasion, when a third edition is put before us, it would under ordinary circumstances be sufficient to chronicle the fact and to indicate any improvement on the earlier editions. But more than that is required now, for this volume is much more than a revised edition of the earlier work; it is to a large extent an entirely new work, dealing with the law on branches of applied electricity which were not touched upon in the book in its earlier form. Before we turn to these new portions, we may glance rapidly over the revised version of the original contents of the book.

The volume is now divided into three parts, of which Parts I. and II. deal with legislation and regulations relating to electric lighting. Part I. gives a general discussion of the legislation on the subject, and those who are familiar with the last edition will be interested to notice how much new matter has been introduced into this part of the volume, by references to Private Acts and Provisional Orders passed since that edition appeared (1900). The author has given also many examples of special clauses inserted in various Acts and Orders, as *e.g.*, a clause in Private Acts of local authorities preventing these bodies from paying a deficit on their electrical undertaking out of the rates (see Bermondsey, Stoke Newington and Woolwich Provisional Orders, 1902, confirmed by 2 Edw. VII., c. 207). This general introduction is of great interest as well as of great value, and contains a vast fund of information in a readily accessible form. In Part II. we have all the Electric Lighting Acts set out, with copious notes appended as in the earlier editions, but we have in addition a new section devoted specially to the County of London. In this section the author discusses the points in which a County of London Provisional Order differs from other orders, and points out—but does not discuss—the instances in London of competition and over-lapping in the supply of electric lighting. The London Overhead Wires Act of 1891, and the bye-laws made thereunder, are also set out here, and also the London County Council Regulations for the prevention of fires in theatres and public buildings. Taken together, Parts I. and II., in their present form, not only maintain the high reputation of the book, but are likely to add to it considerably. The author has evidently followed closely the proceedings of Parliamentary Committees and of the Board of Trade, and has gathered together a very complete record of recent progress. The change made in the Board of Trade regulations two years ago as to change of voltage of supply is now incorporated in the text.

Part III. is new. It will be noticed that the title of the work is altered in this edition, as traction and power are now introduced. This, of course, widens considerably the scope of the work, and Part III. is added to deal with the new matter. It is divided into four sections. The first is entitled "Leakage and Electrolysis," and gives the history of the question of liability for electrolytic damage since that question first arose in 1893 in National Telephone Co. *v.* Baker. Those who followed the discussions on this question before the Parliamentary Committees during the last two sessions will be glad to find in these pages a full account of the result of all such discussions. It may be that in course of time, when our experience is greater, Parliament may adopt a definite attitude towards this question of liability for damage by electrolysis, but up to the present time different Committees have acted differently, and in consequence the law on the subject is different in different communities. Mr. Will's chapter might seem a strange medley of contradictions to a person who had not followed the recent history of the subject, but it is, in fact, a very true representation of the present law. In later years we shall, no doubt, find order arising out of chaos, but at present the position of affairs can only be explained by setting out what has been done in each individual case, and this is the plan adopted by the author.

The second section deals with tramways and light railways. The author has not attempted here to go into the subject in full detail, so that we do not find the Tramways Act, 1870, or the Light Railways Act, 1896, set out in the text, or their effect discussed. It may be questioned, therefore, whether the book can be said to give "the law" of electric traction, as stated in the title, but it certainly gives some useful information on that subject, mostly in the form of copies of the most recent regulations made by the Board of Trade for tramways and light railways worked on the trolley, conduit, or surface-contact system. We should have been glad if the author had gone into the question of electric tramways as completely as he has done in the case of electric lighting, examining private Acts for special clauses forming precedents for future action. For instance, the Aberdeen and Dundee clauses, adopted later in the Rochdale Act of 1900, which are analogous to the clauses we have referred to above in the Bermondsey and other provisional orders for lighting, are of great importance in connection with municipal trading in tramways, and deserve to be mentioned. We recognise, however, that to deal with the subject of traction fully would practically require another volume, and Mr. Shiress Will may not have felt inclined to increase his work to such an extent.

Two chapters still remain to be considered. One deals with the Tubes and other electric railways authorised by Parliament, and is really a useful *précis* of the proceedings in Committee during recent years. It sets out all the various companies with statutory authority, discusses the powers usually conferred by Tube Railway Acts, and gives the Board of Trade Regulations. The final chapter gives a short discussion of all the Power Acts which have passed Parliament, showing the general nature of the schemes and indicating resemblances and contrasts in the powers granted in different Acts.

If we cannot say that Part III. gives a full discussion of the law of electric traction and power, it certainly makes an interesting and instructive addition to the work, and will be found very useful by all who are concerned in schemes for electric railways or power distribution. It is quite clear that our laws dealing with the applications of electricity are as yet in a transition stage. Precedents are being formed—in some cases, we fear, more by chance than good guidance—and in years to come definite rules may be evolved and finally formulated in new public statutes; but at present a glance at Mr. Will's volume is sufficient to show that there is a great want of definiteness in the practice of Parliament on electric tramway, railway and power Bills. A close study of what has been done in individual cases, is the best means of obtaining guidance for the future, and Part III. of the present volume enables the reader readily to obtain this information. As to Parts I. and II.—the revised version of the old book—we have already indicated that they are in every way excellent. The cases bearing on the law of electricity supply have all been carefully considered, and the volume is thoroughly up-to-date, as it contains a notice of the very recent decision of the Court of Appeal in the Finchley Case. A recommendation of the book is scarcely necessary at this date, but we may say that the new edition appears to us to be in every way an improvement on the earlier editions, and to constitute a work highly creditable to the author, and very useful to the public.

CORRESPONDENCE.

The "Laws of Magnetism."

The *Electrical World*, New York, has published my theory of magnetism in No. 25 of December 20th last year. In the meantime I have finished the whole work, and I am now able to give the following brief and chief "laws":—

1. Iron as a shell or aiding of an electro-magnet outside the solenoid does not become polarity, but is only a protection.

2. Long arms or shoes at the free ends of magnets are not so-called poles, but concentrate the power between

them; the poles are existing only at the ends of the solenoid.

3. Iron near a magnet (outward of a solenoid) does not become a magnet, it is only an obstacle or a resistance to the magnetic force which is directed to the poles.

4. The magnetism is only an electrical force, but no special "magnetic" force.

5. The magnetic phenomenons insist on electrical pressure.

6. The electric and so-called magnetic phenomenons are following the ordinary and well-known mechanical laws; there are no special laws, no attractions or special so-called unknown phenomenons.

7. In a magnetic field there is not both pressure and attraction, but only electric pressure.

8. The force of magnetism of steel is existing only in the surface of the material; it is a skin effect.

9. The magnetic forces or waves can be derivated, dispersed, or refracted, as the electrical or the light waves, all three have the same motive source; the motion of the ether.

Everybody can prove these points by experiments; * there is no more theory, but only facts and reality, but the old teaching was a phantom.

Joh. Zacharias.

Charlottenburg, Germany,
April 15th, 1903.

[Quite so. We may add that the earth is flat, and surrounded by water; the sun goes round the earth, and the moon is made of green cheese.—Eds. Elec. Rev.]

Wanton Waste.

In your leaderette this week on the waste of "fine slack," there seems to be an inference that this slack can only be used satisfactorily by means of forced draught appliances, but I should like to point out the enormous field for the use of fine slack in connection with mechanical stokers of the chain-grate type. In the station with which I am connected we are burning the cheapest slack we can buy, on chain-grate stokers. This combination gives every satisfaction; our coal figures are low, from 6 lbs. to 7 lbs. of slack per unit generated. The slack is well watered and "caked" before being put into the hoppers, and burns well, leaving practically no clinker and very little ash. We have no smoke trouble. The only sad part of the business is, that we have to pay something like half-a-guinea a ton for fuel which, on your own figures, is sold at the pit mouth for 6d. Into whose pockets does the odd 10s. go?

One hears a good deal from time to time against mechanical stokers, but I think it is mostly from people who have failed to learn the trick of working them and given them up in disgust. There is only one proper way of working chain-grate stokers, and, unless they are so worked, no fireman, however skilful with ordinary furnaces, can keep his steam. Worked properly, they will burn in a highly efficient manner, what many people, going over the station and looking into the bunkers, call "dirt." I enclose my card and remain.

Slack.

April 18th, 1903.

On Coherence.

I have read "O. D. L.'s" remarks in your last issue on my letter "On Coherence," with interest, and I must say, though not agreeing with his theory, that it is one which certainly merits attention. The tests he mentions in the first part of his letter on a coherer with a movable plunger do not at all, I think, meet the case, as "O. D. L." will probably see on reflection; let me explain, now, why it is that in his experiment, Case 2, the resistance of the filings does not decrease as much as in Case 1. The explanation is very simple; in Case 2 the filings, not being under any magnetic influence, are all in a higgledy-piggledy order, *i.e.*, they are pointing in every direction; now, it is not evident that in this case a much greater amount of compression would be required to bring the filings together to the same extent, so as to make as good a contact with each other, than if they were all in order, end on to one another, pointing parallel to the tube of the coherer. I have every reason to believe that if the filings could be held in the same position as they would occupy if in a magnetic field having lines parallel to the tube, and assuming that they did not increase in length under the magnetic influence, then by compressing the plunger as in Case 2, the $\frac{1}{500000}$th part of the space occupied by the filings, the resistance would decrease to at least the same amount as it would in Case 1. I do not want to take up too much of your valuable space, but let me explain that according to my magnetic theory, I believe that the magnetic lines or waves radiated from the transmitting antenna travel in a direction, and maintain a fixed position, parallel to the vertical planes of the antenna; from this it will be seen that if the transmitting and receiving antennæ are not parallel to one another, the magnetic wave from the transmitting antenna cannot strike or cut the whole of the receiving antenna, with the result, of course, that the cohering effect of the magnetic wave at the receiver is greatly lessened; this explains why it is that to obtain the best results the two antennæ should be parallel. I am also inclined to the belief the magnetic wave does not induce a current in the receiving antenna, but rather that the magnetic wave itself is distorted and caught as it were by the antenna; it is on this proposition that is based my theory, that the magnetic field surrounding the coherer on the impact of a magnetic wave always has lines parallel to the tube of the coherer. According to this theory, the explanation of the fact that the magnetic waves can travel further over sea than over land, is due to the cause that on land many large metal surfaces, such as house roofs, metal or iron towers or bridges, or even large deposits of metal or other ores in the ground, &c., are interposed in the path of the wave, all these metal obstructions tend to distort and weaken the magnetic effect.

W. P. B.

* "Glaser's Annalen," Berlin, No. 5, March 1st, 1903, pp. 88—93.

Municipal Loans.

I thank you for your remarks on my letter in your last issue, but I must confess that I do not altogether agree with them.

In the first place, I do not say that all the renewals would take place exactly at the end of 25 or 30 years: what I pointed out was that "if it were necessary to renew the plant at the end of that time," you ought to be in a financial position to do so, and this you have shown me can be done without a 3 per cent. depreciation fund.

In a few municipal electric lighting orders which I have gone into, the only form of fund that I can find that the undertakers have power to set aside out of revenue, is the reserve fund, which fund can at *no* time exceed 10 per cent. of the original loan: there is no mention of any depreciation fund. How, then, can one set aside 3 per cent. annually for depreciation if one has no power to do so? If you started to set aside 3 per cent. annually from the commencement of the undertaking, you would soon come to the 10 per cent. limit, as, according to your own showing, accumulators which are rated as one of the most perishable parts of the plant are estimated to have a life of at least 10 years. Accumulators, as well as the rest of the plant, must be kept in perfect running order and repair, year by year, out of the current revenue for the year, the reserve fund, and if these together do not make up the necessary amount, it is necessary to come on the rates.

You ask "How can a sound business be built up on the basis of a fresh start, with fresh capital every 25 or 30 years?" I do not see where a fresh start would come in, as no one would consider that an undertaking was making a fresh start, that had already built up a large business in the way of consumers connected. The goodwill of a concern in these days of keen competition should be certainly of great value to the undertaking; further, do I understand you to mean that unless an undertaking in 25 years reduces its capital by a sinking fund to nothing, and also, provides what is practically fresh capital to take its place by means of a 3 per cent. depreciation fund, as well as keeping the plant in good order and repair out of revenue and the reserve fund, that it is impossible to build up a sound business?

As to the contention of there being a valuable asset remaining when the loans for the plant are paid off, being a fallacy, I entirely disagree with you. If, after all, short-lived plant has been kept in perfect running order, and renewed, if necessary, out of current revenue, the reserve fund or the rates, as it must be, surely you would not suggest that the plant, whose estimated life is longer than the period for which the loan is granted, such as buildings, mains, &c., will "suddenly collapse and cease to exist" as soon as the last instalment of the loan is paid off! I cannot see where the fallacy you mention comes in; but if, as you state, there is such a fallacy, I should be most grateful for your esteemed enlightenment on this most important subject.

David Smith.

London, *April 20th*, 1903.

[Our correspondent takes the view that when plant has been paid for by the operation of the sinking fund, and is also in need of renewal, it is sound policy to raise a new loan to replace the old plant. Under these conditions the municipality is for ever saddled with a debt which must increase as the capacity of the plant increases. This is a condition which we cannot regard as financially sound.

As for the ways and means of providing a depreciation fund, surely Mr. Smith credits municipal accountants with less ability than they deserve, having regard to the ingenuity which they display in framing their accounts. First, will our correspondent favour us with a list of authorities which have reached the 10 per cent. limit of reserve? We doubt whether there is one instance. Secondly, we may point out that there is no limit that we know of to the annual payments to the sinking fund; and if, instead of paying 3 per cent. to the sinking fund and a like amount to reserve, the sinking fund instalments are raised to 6 per cent. (after the 10 per cent. limit of reserve has been attained), the difficulty disappears. The loan will be paid off in half the time, and the payments can then be applied to renewals (which will be necessary by then) as they accrue.

Referring to Mr. Smith's fourth paragraph, we do not mean what he there states. Our position is this—that when the loan is extinguished, the undertaking ought to possess plant that is up-to-date at that moment, and in good order. We attach no value to obsolete plant, no matter how well it has been maintained. As for the buildings, their value is small compared with the whole capital outlay. Mr. Smith might save himself the trouble of telling us what we do not suggest, as we know it. The fallacy that we have pointed out *ad nauseam* is that 30-year old plant is as good as new. —Eds. Elec. Rev.]

THE ENGINEER AS FINANCIER.

A lengthy and interesting article appears in *Cassier's Magazine* on the above subject from the pen of Dr. Robert H. Thurston, from which we made the following abstract.

The engineer's problem, in its most general form, is ultimately always a financial one, and may be concisely stated thus:—To provide for a prescribed result, in construction or production, in such a manner as to make the investment one of maximum return. It is always maximum financial result at minimum cost which is sought, and this is really the engineer's final problem in every case, however great or small the work.

The whole business of the engineer, broadly described, is the transfer and transformation of energies in such manner as to most effectively contribute to the wealth of the world in permanent and intrinsically valuable forms. He applies energy derived from a prime mover to the production of iron or steel, cotton or woollen cloths, and the product then represents stored energy in an amount which is always measurable in terms of money, as was the energy which produced it, either through transformation, as out of heat, or by transfer, as from a waterfall.

As there is a "mechanical equivalent" of heat and a "thermal equivalent" of dynamic energy, an electro-chemical and a thermo-electric quantivalence, so there is, always and at all places, a precise equivalence of values between the financial representative of energy and the physical, and the price of a horse-power-hour is the measure of this quantivalence in money.

Money is not only the mechanism of exchange, but it is an element in that mechanism through the fundamental fact that, like fuel, like compressed air, like falling water, or like the chemical arrangement of the storage battery and its elements, it is a true potential energy storage system, its unit of energy capable of being exchanged, on definite terms, at any stated time and place, for any other actual energy or any stored or potential energy. It is to be reckoned in the engineer's processes as energy, and to be collected, stored, transferred, transformed, exchanged, precisely as other energies or representatives of energy, always with a view to gain by each step, each contributing more or less directly to the transformation of Nature's energies into permanent wealth, while, at the same time, contributing, in the process, to the pleasure, happiness, and comfort of mankind.

The engineer is furnished with a certain amount of energy, actual or potential, in money or in credit, and is expected to utilise that potential energy in the production of machinery, apparatus, structures, or of systems of production, &c., and always in such manner that those who provide the initial store may secure a toll in financial energy from every transaction in which they are enabled by the engineer to take part.

It may thus be said that the problem of the engineer is the transformation and transfer of energies in such manner as to secure, ultimately, the conversion of the potential energy stored by Nature in the materials of commerce and engineering into potential energy in the form of manufactured products.

This problem takes this form:—Required, the production of a specified article, in a stated quantity, at minimum cost in capital invested in the machine and in operative expenses, including interest, insurance, maintenance, repair, and replacement. In common parlance, it is required to invent, design, construct, and operate a machine in such manner that it shall produce, in the demanded amount, a certain product, and at a profit to the purchaser and user of the apparatus.

If his machine cannot produce a profitable excess of stores of energy, he and his machine are alike failures; if he cannot secure a larger profit by his new construction than is usual with the old, he and his machine are, at least, not successes. The successful solution of the problem means a real and substantial advance upon current practice and a considerable increase of profits by the adoption of the new machine.

The two problems of maximum commercial or financial efficiency are liable to be confounded, and sometimes appear to be identical; but they are actually distinct, and their solutions are, in some instances, as distinctly different, and occasionally are very greatly different.

The designer's problem is enunciated thus:—

Given, the magnitude of the product to be provided for, in the unit of time, as the hour, the machine cycle, or per annum. Required, such a construction as will furnish that quantity and quality of product at minimum total current expense.

The owner's problem is the following:—

Given, the magnitude, the physical and financial and commercial conditions affecting the operations of a certain machine already working. Required, the quantity of the product to be demanded, where that quantity may vary, such that the return may have maximum value and give maximum profit.

With the crude apparatus of the earlier stages of uneconomical and incomplete industrial systems, there usually exist great opportunities for improvement by refinement of the apparatus and by systematising the industry at, often necessarily, increased cost in the form of invested capital.

Later, the possibility of further improvement lessens, and the costs to secure any given gain increase, until it ultimately becomes a fact that more must be paid for a given gain than it is worth, and the net outgo on the improved apparatus or system becomes, interest and sinking fund included, more than that on a less perfected machine or system. What may be called a "golden mean" is thus always found at that stage at which the cost of additional economies will exceed the necessary cost of securing them, and where the result is loss rather than gain. The resultant of the two tendencies takes a direction which thus tends towards the unprofitable, and a limit may thus always be expected to be found, beyond which further refinement is financially undesirable.

In the case of lubrication, the flooding of a journal with oil which is allowed to go to waste may reduce the wasted power to a minimum; but the cost of the oil in excess of that of wisely liberal and profitable supply may prove, on the whole, productive of a net loss.

The maximum returns on the unit of capital are frequently the result of a great number of widely differing and often conflicting conditions, and the insurance of the highest result, in such instances, evidently presupposes wisdom, judgment, experience, and special talent in exceptional degree.

Because of this complexity of conditions in the common case of the operation of any great business enterprise and the constant flux and reflux of external, and often controlling, commercial conditions, it is very generally true that the most brilliant genius or the most learned expert may sometimes be quite at fault in the presence of the practical questions constantly arising, on the correct response to which success depends, and on the erroneous answer to which follows failure. It is wisdom and experience, rather than genius and learning, which here lead to safe and fruitful methods and ensure the maximum returns.

It is only science which can to-day read an oracle of the future, and it is thus that the man of achievement avails himself of science, always the engineer's guide and leader.

Almost everywhere in the experience of the engineer and of the upbuilder of any commercial or manufacturing enterprise, it will generally be found that there are conflicting conditions, and that the insurance of the highest returns from one element of the system can be had only by sacrifice of returns on some other, and the line of the "golden mean" of compromise must be run, not only through this system of inter-dependent elements, but throughout the whole great organisation. It is this fact which makes so much depend upon experience and good judgment, on a clear, calculating brain, a sound common sense and a well-poised character, uniting

courage and promptness of decision with a habit of fine analysis of those conditions which must determine the decision.

As regards location of works, the two main points to consider are ease of transport, and economical production of power.

As a rule, that location is best which, while maintaining independence by providing alternate lines for shipment, makes the sum of the distances over which transportation is carried on a minimum, or, more correctly, that which makes the aggregate of costs of all transportation charged against the business a minimum, and permanently so.

As regards the internal conditions, the labour question often requires more serious study than any other, and the insurance of an ample amount of skilled labour for the finer work, of unskilled labour for the coarser, of a satisfactory reserve for emergencies, of comparative safety against embarrassment by outside interference, will usually be found to demand most thoughtful and careful study.

An industrial system has maximum financial efficiency when, as a system, it produces a maximum value and quantity with a given use of capital, and when that product is so distributed as to give maximum returns to the people as a body.

The maximum product per capita and maximum production per unit of capital go together, both being attained by utilisation of invention and of labour-assisting machinery.

The insurance of constant employment of the labour engaged in that occupation with maximum productivity of each individual is secured by his steady work with highest skill throughout the most suitable working day, by the employment of machinery for every task which can be assigned it, by the making of man and machine in highest degree fruitful of profit, making each capable of doing a large amount of fine work, by the minimising of costs of raw material and of marketing finished product, by avoidance, throughout the system, of labour which does not contribute to economical production.

The industrial system will exhibit maximum commercial and financial results when it most completely meets the needs of the time with maximum production of the products of manufacture, minimum labour applied to agriculture, the shortest working day consistent with provision of the whole people with a satisfactory supply of the necessaries and comforts of life, and a reasonable amount of reasonable luxuries, sharing its output fairly in proportion to the earnings of its individual workers above a proper minimum.

The engineer's noblest task is thus to be finally accomplished, and his greatest problem solved by the reduction of all industrial systems and their details to a perfection which is defined as that of maximum financial efficiency. But this definition, which savours of the world of "commercialism," is really but the scientific statement of the fact that it is by the development of the industrial system that we are to enable the people to become better and more intelligent, wiser and more cultured and more just, that the progress of the nation and of the race is to be assured.

Maximum financial efficiency means maximum wealth; maximum wealth means maximum opportunity; maximum opportunity means that the people will constantly more and more follow their noblest aspirations and steadily gain in spiritual, moral, intellectual, physical, and even conventional ways. The engineer, as financier and as the builder of the modern industrial system, is the essential pioneer in the mission work of the coming civilisation.

It is for the engineer, not only as financier, but as leader in industry, in finance, in applied economics, and in statecraft, as the man who is expert in the arts, in the finance, the organisation, and administration of the system of production, to insure the safe and efficient operation of all for which government itself is organised. It is the engineer who must assume the largest responsibility, and who has the largest opportunity in this promotion of the best interests of mankind.

LEGAL.

Patent Exploitation, Ltd., *v.* American Electrical Novelty Manufacturing Co.

This case was before Mr. Justice Buckley in the Chancery Division of the High Court of Justice on Tuesday.

Mr. Astbury, K.C., who appeared for the plaintiffs, a Cheshire company, said the action at the last sitting was specially fixed for hearing on the 23rd of this month. It related to a patent for dry cells. An action had been previously tried in which the plaintiffs went through all the particulars of objections, and he understood the present action was to be tried on these particulars. It seemed, however, that that was not the case, and a number of further particulars had been put in which were of an extraordinary character. He was not, under the circumstances, ready for trial, and asked for an adjournment. The Court in the previous action had held that pulverisation was an essential part of the patent, and it was bad because the patentee had not claimed pulverisation. The Court of Appeal, however, thought that the language of the claim was sufficiently wide to embrace pulverisation, and held the patent to be good.

Mr. Walter, for the defendants, said that no doubt they had raised a number of objections which were not relied on in the last case, and he did not object to an adjournment. The plaintiff had a very nasty lot of objections to deal with.

His Lordship directed the case to keep its place in the list, but to be marked not to come on before May 12th.

A STEREOSCOPE FOR RÖNTGEN RAY PHOTOGRAPHS.

The ordinary stereoscopic photographs are produced by a camera having two lenses separated by a distance approximately equal to the distance between the eyes, or a camera with a single lens may be used, the two views being obtained by displacing the single lens by the interocular distance before the second view is taken. Stereoscopic Röntgen photographs can be produced in a similar way by using two focus tubes, or by using a single tube in two successive positions. But Röntgen photographs produced in this way are always too large for use in the ordinary hand stereoscope. Reduced photographs could, of course, be made from the

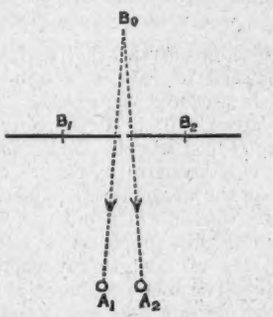


Fig. 1.

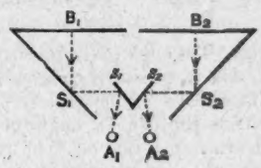


Fig. 2.

negatives, but this would be a troublesome proceeding, and much of the fine detail of the photographs would be lost. The Wheatstone reflecting stereoscope might be used to view these large photographs, and it has hitherto been frequently employed for this purpose. But there are several objectionable features in the reflecting stereoscope that are not found in the direct-vision stereoscope. For example, secondary images are produced by the reflections from inclined mirrors, and the luminosity of the images is much less than in the direct-vision stereoscope. The apparatus is also large and clumsy, the height of the apparatus requiring to be always a little greater than that of the object photographed.

Dr. Walter, of Hamburg, has devised an ingenious direct-vision stereoscope capable of viewing photographs of any size, consisting of a combination of a wide-angle photographic camera and two simple eye-pieces; for these latter, in fact, the lenses of the ordinary hand stereoscope may be used. In order to understand the construction of Walter's stereoscope a little preliminary explanation is necessary.

The principle of stereoscopic vision with an optical instrument may be explained by means of the diagram, fig. 1, in which A_1 A_2 are the eyes of the person looking in the stereoscope, and B_1 B_2 represent the same point of the object in the two stereoscopic pictures. The optical devices in the instrument must deflect the rays coming from B_1, so that they enter the eye A_1 as if they came from a point B_0, and the rays B_2 must enter the eye A_2 as if they came from the same point B_0. It is also necessary that the distance of the point B_0 from the eyes should not be less than the distance of easy vision.

The diagram, fig. 2, shows how the stereoscopic effect is produced by reflectors.

The rays of light from each of the two corresponding points B_1 B_2 are twice reflected by the mirrors S_1 s_1 and by S_2 s_2. The path of the rays from the points B_1 B_2 to the eyes A_1 A_2 is shown by the dotted lines. The angles of the mirrors s_1 s_2 are so adjusted that the rays entering the eyes when produced backwards intersect in a point at the distance of easy vision. If the ordinary silvered glass mirrors are used in an instrument like this, reflections take place both from the face of the glass and from the silvered back. This produces secondary images, which are all the more distinct when the rays fall very obliquely on the mirror, as must necessarily be the case in this instrument. These secondary images destroy, of course, the sharpness of the picture seen by the observer, and for this reason alone the reflecting stereoscope is very much inferior to the prismatic or direct-vision stereoscope.

E

A prismatic spectroscope adapted for looking at large Röntgen ray photographs may be described with the help of the diagrams fig. 3. Two prisms, P_1 P_2 (in diagram *a*) are inserted in the paths of the rays from B_1 and B_2, so as to deflect them into the eyes A_1 and A_2, as shown by the dotted

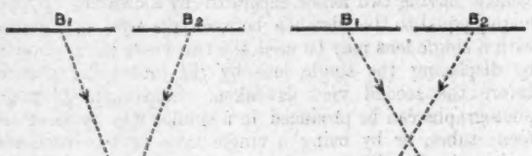


Fig. 3.

lines. The angle of the prisms must be such that the lines from A_1 and A_2 produced backwards shall intersect at a suitable distance. A curious effect is produced by turning the prisms through an angle of about 180° into the position shown in diagram *b*. The eye A_1 then sees the point B_2 and the eye A_2 the point B_1. This produces a picture in which the most distant points in the object appear to be the nearest, and *vice versâ*. This inversion, which produces an unnatural effect when looking at photographs of a landscape, is of great value in looking at Röntgen ray photographs, because it enables the observer to see the object as if he were looking at it from the opposite side, and thereby helps to establish with certainty the relative depths of the different parts of the body under examination.

A prism stereoscope for viewing Röntgen ray photographs is shown in fig. 4. It is similar in construction to an ordinary hand spectroscope, but is, of course, much larger.

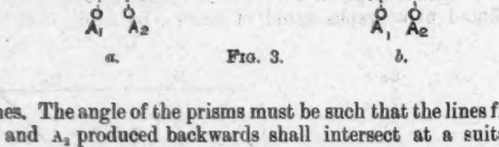


Fig. 4.

The frame in which the prisms P_1 P_2 are mounted slides on a rod projecting from the frame carrying the photographs B_1 B_2. An objection to this form of spectroscope is, that the prisms have to be made achromatic by cementing together different kinds of glass, which makes the instrument very expensive.

In the form of spectroscope invented by Walter there are neither reflectors nor prisms, and many of the disadvantages connected with the previously described constructions of spectroscopes are got rid of. Since lenses only are used in Walter's instrument, he has called it the "lens spectroscope."

If two large stereoscopic photographs are placed at a suitable distance in front of the lens of a photographic camera, two reduced images will be formed side by side on the ground glass plate. By suitably adjusting the distances, these images may be made of a size adapted to be viewed by the ordinary hand stereoscope. The grain of the ground glass, however, will destroy the finer details of the picture. It occurred to Walter, when making this experiment, that the ground glass might be removed, and the images formed in space viewed by suitable eye-pieces, as in an ordinary telescope. Experiment showed that brilliant images giving the finest details could be obtained in this way.

The diagram, fig. 5, will illustrate the construction of the Walter stereoscope. Rays of light from the photographs B_1 B_2 pass through the objective L_0 of the camera, and form images at b_1 b_2. These images are separately viewed by the

Fig. 5.

eyes A_1 A_2 through the eye-pieces L_1 L_2. The rays which enter the eyes intersect in the middle of the objective L_0. Since it is also necessary in a good stereoscope that the distance between L_1 L_2 and L_0 shall not be less than the distance of easy vision, which, in a normal man, is about 25 cm., and since the focal distance L_1 b_2 (or L_2 b_1) of the eye-piece in an ordinary stereoscope is from 10—12 cm., the focal distance of the objective L_0 must not be less than 15 cm.

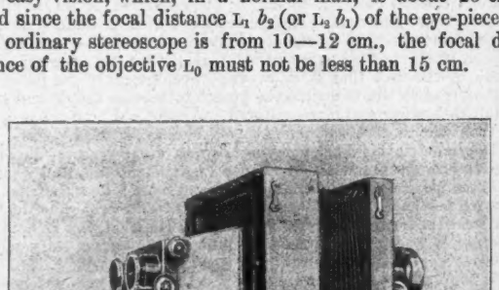


Fig. 6.

It is also necessary that the objective L_0 should be of the rapid or wide-angle type. This is required not only to make the images as luminous as possible, but also in order to get the whole of the large photographs into the field of view. For this latter reason most photographic lenses, except the most rapid, are unsuitable for this instrument. The Petzval objective made by Voigtländer & Son is recommended by Walter as a suitable lens. Walter's lens stereoscope, as it appears when complete, is shown in fig. 6.

The whole apparatus is expensive, but it must not be forgotten that the camera can be used separately for taking instantaneous photographs, and the eye-pieces may be used as an ordinary hand stereoscope.

Blairgowrie and Rattray Lighting.—The T.C.'s have under consideration an electric lighting scheme; it was considered that abundant power for the proposed installation could be got from the river Ericht, which flows between the two burghs.

INCENTIVES TO EDUCATION.

Following up a letter entitled "Commercial Supremacy and Military Service," which he sent to the *Times* some months ago, Sir James Blyth, Bart., has more recently contributed a second on commercial supremacy, wherein he replies to certain correspondents and elucidates his former argument. Taking as his postulate that the crying need of this country is higher education—"be it called secondary or tertiary, technical or scientific"—Sir James Blyth refrains from arguing at length in favour of compulsory military service, to which his sympathies evidently lean, but he points out with considerable cogency the advantages accruing to France and Germany from the conditions and laws accompanying that compulsory service. In France and Germany every male is compelled to serve with the colours for a certain period of time; but the period can be shortened if the recruit shows evidence of having received a certain amount of educational training by having passed a certain standard examination. Among the upper and middle classes of those countries, failure to pass that examination, says Sir James, is regarded as a disgrace; therefore "the whole family energies are set upon this object from the earliest age of the child until manhood, and the result we see is a general plane of education to which comparatively few in this country, in the same classes of society, ever rise, or even seek to rise. Naturally, not being military experts, nor political alarmists, the fact that this examination must to some extent diminish the value of each adult citizen as an amateur soldier does not trouble us; but since failure to pass it has somehow come to be held disgraceful, it is difficult to imagine a stronger weapon which could be put into the hands of the educationalist. We do not know of any sentiment akin to this (even in kind—certainly not in degree) in the United Kingdom: if anything is held to be specially disgraceful among us in everyday life, it is failure to "get on" in the world; failure to amass a competence, failure to make an income of four figures. Therefore, it follows, granting for the moment that compulsory military service is not of advantage to a community, the system upon which it is worked in Germany and France so far neutralises the defects of the principle that it really becomes of benefit to the nation which has sense enough to value mental culture, by socially, if not legally, penalising ignorance.

Accordingly, Sir James Blyth would like to see some method of introducing into Great Britain at least an alternative arrangement to this Continental process for encouraging education by the action of the State; and without putting it forward "by any means as an adequate equivalent for the ever-present incentive which the exemption from or curtailment of military or naval service provides," he suggests "that a generous recognition of ability by the State in Exhibitions, Scholarships, Diplomas, and Royal Orders of Merit, offered in every town and county, to every school and college, should be bestowed on such as greatly excel in any of the very many branches of art, scientific study, or handicraft." It seems clear that the idea is good in principle, though surrounded by many difficulties. It comes practically to State-aided higher education of selected candidates, as a supplement to, or substitute for, rate-aided education of everybody. The latter process has been accepted by John Bull, with some amount of good grace, and we suppose it is an operation which will never be abandoned. It is, however, a lamentable waste of time, human energy, and money, in a very great many cases, and it is not free from positive disadvantages to the community in the shape of harm to health. We have hinted at this circumstance many times, at the risk of being termed retrogressive and ridiculous; but the truth remains that the effect of the modern Board School education upon boys and girls who have not the mental capacity to stand education is disastrous, not merely failing to increase, but actually diminishing their value to the nation in after life. In this connection the latter portion of an article in a recent number of the *Nineteenth Century* by Mr. O. Eltzbacher on "The Disadvantages of Education," is well worthy of study, although the former part is disfigured by a great lack of restraint, and by the apparently inevitable inability of the journalist to appraise the importance of scientific work which is not immediately and directly followed by results of pecuniary value, or which does not appeal to the imagination of the man in the street.

So far as it would lead to a respect for education among our people by seeing the devotees of study diplomaed and starred; and so far as it would encourage our rich men to contribute to starving colleges and the like, Sir James Blyth's proposal would do much good; but it would not stimulate a love of learning, without which love study is all but impossible. A far more potent factor in the creation of a class of men of attainments—men who would achieve some distinction, without entering the foremost rank—would be a decree by the elusive god of fashion that ignorance should be deemed "bad style." Sometimes it is "bad form" to be one thing, sometimes to be another; just now it is very "bad style" to be better read, more intelligent, more mentally alive than the person who gains his information from the columns of a halfpenny newspaper. Unless most carefully watched, Sir James Blyth's scheme would exhibit the danger of encouraging a class of men to read and study for the mere purpose of receiving titles and qualifications which should prove of social or even pecuniary utility, men who would cease to study immediately their end was gained; a decree that ignorance was "bad style" would induce a man to study continuously, lest he be left behind by his neighbours and friends.

Like most other doctrines, that of individualism becomes absurd when pushed to extremes. Most of us have to earn a living; and if we earn it by mental work, we earn it the more easily and the more usefully to others as our mental training is the more profound. It is, therefore, to the benefit of the community, as well as to that of the individual, that a man shall be assisted to acquire knowledge (assuming him to have the capacity for so acquiring it) if he or his parents are too poorly off to give it him themselves. The ideal process is for a man to work (*i.e.*, to earn) and to study at the same time; but at the commencement of his career at least, this is physiologically objectionable, even when not practically impossible, in view of competition. State, or other, assistance of selected persons in an educational direction is accordingly advantageous—to the many as to the few—but it will not produce, it will only on occasion remotely assist in producing, men of the front rank. No system of reward, measured in money or place, exists, or can be devised, adequately to recompense our leading discoverers, inventors, and men of science generally. "In this world the salary or reward is always in the inverse ratio of the duties performed." No external or visible reward, that is; *the* reward, and to a man of well-balanced mind it is adequate (for it is unique) is the work itself; the feeling that one's life has not been wholly wasted. The labourer works to earn his bread and cheese, the commercialist works to pile up useless and inconvenient riches, the man of science works because he must; being compelled by an inner force outweighing any imaginable outward compulsion or persuasion.

We of Great Britain have those men, multitudes of them, they do not exist solely in Germany; and they often die in penury. Our journalists and writers ignore them because their researches are not interesting or popular; and the cry is raised that mental ability is only to be found abroad. If those of our manufacturers and capitalists who are not content to live on their past reputations, gained at a time when rule-of-thumb was sufficient, could be induced to engage such men at reasonable salaries to solve some of the many problems in their industries, giving them a free hand to prosecute their investigations to the utmost; or if, under conditions altered to suit modern life and notions, the old system of "patronage" could be re-introduced for the pecuniary assistance of men of distinction, the country would benefit enormously; and we should soon have little reason to proclaim the mental decay of the British race, or to assert that this country is two generations behind Germany in ability. It is always the bad workman who quarrels with his tools, but it is a worse workman or an ignorant sluggard who refuses to employ those he has.

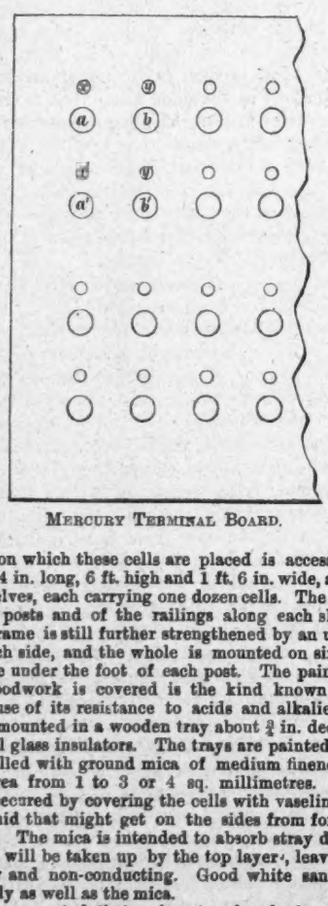
Spain.—A central electricity generating station is approaching completion near Arganda del Rey for the electric lighting of the town. The water-power of the River Tajuna is being utilised in connection with the plant.

A CONVENIENT STORAGE BATTERY INSTALLATION.*

By W. J. HUMPHREYS.

A good storage battery is justly regarded as one of the most essential things in the equipment of a physical laboratory. Its value, however, both as a reliable and convenient source of electric currents and as an instrument for instruction, depends largely on the way in which it is set up; and while it would seem that there could be no trouble whatever in adapting so simple a thing to the use of students, I suspect that others, like myself, have found the problem not wholly free from difficulties; at least, such was my experience when I undertook, some four years ago, to so fit up a storage plant that it would meet the various needs, other than those of lighting and power, of our new laboratory. Nor was I able to get helpful suggestions from any of several sources to which one would naturally turn for such directions. But I did obtain much kind and valuable information from Prof. Hering, who had just completed an excellent storage installation in the physical laboratory of the Johns Hopkins University. I should probably have tried to duplicate his work in every particular but for the fact that the means at my disposal, and some of the objects in view, compelled modifications and simpler plans. The mounting finally used has cost but little, is convenient in every particular and suited to teaching and general laboratory work. A test of four years has not suggested desirable changes, and, besides, it has so commended itself to others that it is now adopted in several institutions. I therefore, in response to many requests, offer a brief description of its essential features, trusting that in this way I may serve some one who has occasion to instal a storage plant for similar purposes.

The battery I shall describe consists of 36 cells of the "Chloride accumulator," type E, with glass jars, but evidently the same plans can be used for any number and any type of cells.



Mercury Terminal Board.

The frame on which these cells are placed is accessible from all sides, is 8 ft. 4 in. long, 6 ft. high and 1 ft. 6 in. wide, and is divided into three shelves, each carrying one dozen cells. The cross-sections of the corner posts and of the railings along each shelf are $2\frac{3}{4} \times 3\frac{1}{2}$ in. The frame is still further strengthened by an upright at the middle of each side, and the whole is mounted on six heavy glass insulators, one under the foot of each post. The paint with which the entire woodwork is covered is the kind known as "tileite," selected because of its resistance to acids and alkalies. Each cell is separately mounted in a wooden tray about $\frac{3}{4}$ in. deep that stands on three small glass insulators. The trays are painted with asphalt varnish and filled with ground mica of medium fineness, the flakes varying in area from 1 to 3 or 4 sq. millimetres. Still further insulation is secured by covering the cells with vaseline, which prevents any liquid that might get on the sides from forming a continuous layer. The mica is intended to absorb stray drops of water or acid which will be taken up by the top layer, leaving the lower ones still dry and non-conducting. Good white sand would probably do nearly as well as the mica.

It has been suggested that carbonate of soda be added to the sand or mica, since this would unite with the acid, should any get on it, and produce dry non-conducting sulphate of soda, but there is a chemical action between the carbonate of soda and the mica which, though it takes place slowly, soon produces a damp, unsatisfactory mass, that can do no good, and is likely to do much harm.

The liquid in each cell is covered with a layer, about $\frac{1}{4}$ in. thick, of paraffin oil. This prevents excessive evaporation during very dry weather, and absorption of moisture that might cause disastrous overflowing when the air is particularly damp. Besides, the disagreeable and corrosive acid spray, caused by the bursting of bubbles while the cells are being charged, is well nigh wholly avoided. Apart from the comfort this gives, it makes it safe to have apparatus near the battery, avoids the necessity for extra ventilation, prevents fouling of the battery frame and preserves the insulation.

The above precautions against leakage may be excessive, but they are easily made, and I have had no trouble whatever from imperfect insulation during a constant use of the battery for four years, though it is placed in a small basement room that has often been very damp, nor has it been necessary to renew or clean any of the insulating materials.

Two large copper wires, of very low resistance, run from each cell to the switchboard, which is placed just beyond a partition near one end of the battery frame. These wires are soldered to the terminal lugs of the elements, and thus the trouble due to corroded and bad connections is avoided. Each wire is also soldered to a fuse block conveniently located above the switchboard. According to my experience, it is far better to use fuse links provided with flat copper terminals, since fuse wires, when clamped down with screws, frequently get loose and give bad connections. The links seem to be free from this objection.

The switchboard, which lies horizontally in a suitable frame, consists of a close-grained white marble slab, 2 in. thick, 12 in. wide and 40 in. long. This slab is drilled through with holes the proper size to take the wires from the battery that come up from beneath, bend over, and terminate in near-by larger holes about $\frac{3}{4}$ in. deep, that contain mercury.

I will say for the benefit of those who have occasion for the first time to drill marble, that it is an exceedingly easy thing to do. I use for this work a sensitive drill press and ordinary twist drills. It is only essential to use plenty of water as a lubricant, but, of course, it is also desirable to keep the drills reasonably sharp.

For the sake of compactness and convenient spacing these holes are arranged in two double rows as illustrated in the figure, which shows a part of the slab as laid off or drilled, but without connections. The cups, a, b, and so on, are connected by wires through x, y, ..., say, to the positive sides of the cells, while a', b', and so forth, are similarly connected through x', y', ..., to the negative sides of the corresponding cells. In this way the slab, by its pairs of mercury cups, becomes a simple representative of the entire battery, one that any beginner can understand, and by means of which he can readily test the voltage of all sorts of combinations.

To connect the cells in multiple or series straight heavy wires with their ends bent down are used. The mercury cups are so spaced that the wires connecting them in multiple, that is, of sufficient length to unite a and b say, are too short to connect the positive and negative sides of a cell, while those used for joining in series, and therefore reaching from a to b', are too long to connect opposite sides of the same cell. In this way the chances of short-circuiting are materially reduced, a feature by no means undesirable in a laboratory battery.

The wires of the various laboratory circuits are soldered to a row of fuse blocks above the switchboard, and connection between them and the mercury cups is secured by means of flexible cords, also soldered to the fuse blocks that terminate with a short section of solid copper. I used, for these terminals, heavy wires about 1 in. long, drilled axially deep enough to admit the ends of the flexible cords, which, of course, were soldered in place. As a matter of convenience, each circuit is correspondingly numbered above the switchboard and at the terminal end.

A rheostat, a circuit breaker and an ammeter in the charging circuit, and a voltmeter for testing the cells, all close beside the switchboard, complete the outfit.

* *Physical Review.*

SERIES VAPOUR ENGINES.

Continuing his articles in the *Journal of the Franklin Institute*, Prof. Thurston points out the difficulties inseparable from the secondary fluids used in series vapour engines. Sulphur dioxide, like ammonia, is a most disagreeable vapour to get loose into the atmosphere, while the inflammable vapours of ether or bisulphide of carbon have their particular dangers likewise. A feature of sulphur dioxide, as of other available secondary fluids, is its comparatively small susceptibility to the evil of cylinder condensation often so very serious with steam. A peculiarity of the dioxide is that it is oily, and a good lubricant for the rubbing surfaces, but it must be pure and dry, or it will take up moisture and oxygen and become acid and useless.

The experimental engine of Prof. Josse, tried at Berlin, is of triple-expansion type of 150 B.H.P., 150 revolutions per minute, with cylinders of 270, 430 and 675 mm. × 500 mm. stroke. To this was added a "cold vapour engine" of equal stroke, and 266 mm. diameter, in which a pressure of 215 lbs. was provided for. The vaporiser and condenser contain 753 and 1,720 sq. ft. of heating surface respectively. Their pressures are 285 and 115 lbs. The feed pump absorbs $\frac{3}{4}$ per cent. of the power developed. The cycle was—(1) the steam passed through the engine; (2) entered the vaporiser of the SO_2 and was there condensed, and its residue of air removed by a dry air pump. The secondary vapour of the condenser, which was the boiler on the non-water side of its tubes, went forward to the secondary engine and thence to the SO_2 condenser, whence it was pumped back to the vaporiser.

The absence of cylinder condensation of the secondary fluid seems curious. It is rarely less than 20 per cent. in a steam engine, usually much more.

The best result as regards the steam end of the combination appears to have been 11·2 lbs. of steam per I.H.P.-hour. Combined with the secondary engine, the power was obtained with as little as 8·36 lbs. of steam.

The electric output ÷ I.H.P. was 80·1 per cent., while the B.H.P. ÷ I.H.P. was 86·2 per cent., and even 92·5 per cent. in a case where the steam was 9·85 lbs. per total I.H.P.-hour. The result of 8·36 lbs. of steam per I H.P.-hour is said to be the best on record. The secondary engine, in fact, added 34·2 per cent. to the power obtained from the steam.

Where in other tests a gain of 35·1 per cent. of power was secured, the economy was 26·3 per cent. Superheated steam enables the combined engine to benefit even more than the plain steam engine. The best results were obtained, it appears, when the vacuum of the primary engine was not at its best, showing that the secondary vapour benefited more by the extra temperature than was lost by the primary. The secondary fluid loses little by cylinder condensation, because it undergoes a comparatively small range of temperature in the cylinder, is little susceptible to heat exchange with the cylinder metal, and probably, also, because it has a high density of 32 as against 9 for steam at 0° C. and 1 atmosphere. For a vacuum of 24 in. in the steam condenser, the secondary vapour had a pressure of 156 lbs. For a 21-in. vacuum it had 199 lbs.

About 5 to 7·5 sq. ft. of surface per I.H.P. is required in the secondary vaporiser and 20 to 25 in the condenser, which is much in excess of that usual in steam work. Secondary vapours require large pipes and ports, or they lose much in pressure.

It is considered that with a secondary engine it is better to cut out the intermediate cylinder of the triple engine, and so convert it into a high ratio compound. More condensing water, on the whole, is needed. Apart from the steam engine these low boiling point vapours may be used in many places where waste heat is now lost, as, for example, where hot gases flow away from a blast furnace or a coke oven, or even a gas engine or behind the economiser of a steam boiler. The larger the installation the better will it pay. As regards cost, it is considered that per horse-power-hour produced the binary engine should cost actually less than ordinary steam power plant, though experience is wanted to fix the durability of the new engine.

Finally, Prof. Thurston concludes with what has been often urged in these columns, that the simple engine with superheat may become the equal of the compound or triple, a fact of which electric traction engineers should take note, instead of wasting money over large and costly compound engines to drive a few tramcars with the inevitable poor load factor incidental to all small systems.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending April 22nd, 1902.		Week ending April 21st, 1903.	
Aarhuus. Teleg. cable ..	Value £52	Adelaide	Value £274
Alexandria	176	„ Teleg. mat.	572
Amsterdam	180	Alexandria	265
Auckland	210	„ Teleg. apparatus ..	286
Buenos Ayres. Teleg. cable ..	160	Amsterdam	352
„ „ Teleg. mat. ..	896	Auckland	228
Calcutta	1,708	„ Teleg. mat.	127
Cape Town	319	Bangkok	368
„ Teleg. mat. ..	1,143	Bombay	58
Channel Islands	60	Boulogne	218
Christiania. Teleg. wire ..	24	Buenos Ayres	4,060
Colombo	12	Calcutta	1,902
Copenhagen. Teleg. wire ..	25	„ Teleg. mat.	378
Durban	579	Cape Town	177
East London	546	Colombo	579
Fremantle	42	„ Teleg. mat.	953
Hamburg	217	Copenhagen	1,038
Karachi	60	Delagoa Bay	891
Melbourne	85	Durban	1,587
Odessa	190	„ Teleg. mat.	1,707
Otago	40	East London	223
Perth	45	Hong Kong	19
Reval	74	„ Teleg. mat.	12
Sierra Leone. Teleg. cable ..	6,500	Lyttleton	10
Stockholm. Teleg. wire ..	385	Madras	272
Sydney	104	Melbourne	660
„ Teleg. wire	478	Montreal	90
Valparaiso. Teleg. wire ..	316	New York	330
Wellington	21	Otago	198
„ Teleg. mat. ..	256	Penang	10
		Perth	189
		Port Elizabeth. Teleg. mat. ..	238
		Port Said	42
		Rangoon	56
		Rotterdam	136
		St. Helena. Teleg. mat. ..	24
		San Sebastian	21
		Shanghai	789
		Singapore	79
		„ Teleg. mat.	739
		Stockholm. Teleg. mat. ..	40
		Sydney	229
		Yokohama	18
Total ..	£14,809	Total ..	£19,801

Foreign Goods Transhipped.

Cape Town. Elec. mat.	Value £25
East London. Elec. apprts. ..	17
Total	£42
Otago. Elec. mat.	Value £270

New Publication.—We have received a copy of the first number of the *British Inventor*, a nicely printed 1d. monthly journal devoted to the interests of inventors and manufacturers.

Refuse Destructors for South Africa.—Immediately after the war, at the instigation of the Government, the Municipality of Johannesburg sent over a special Commission to investigate the various systems adopted for the sanitary disposal of refuse in this country. Afterwards tenders were invited, and the order was placed with Messrs. Meldrum Bros. for two units of their regenerative Simplex destructor, each consisting of four grates or cells, with water-tube boilers of 1,966 sq. ft. of heating surface and regenerators for heating the air for combustion by means of the waste gases on their way to the chimney. The capacity of the plant is 120 tons per day. The contract also included iron building and tipping platform and a steel chimney 75 ft. high, by 6 ft. internal diameter. We understand that 65 days only were allowed for the completion of the first half of the order, as well as of the house and chimney, and this time has been well kept, as all the material, as well as a large part of the second half, has already gone to Birkenhead for shipment by the ss. *Oronsay*. Considerable interest attaches to this installation, as it is the first high temperature destructor sent out to South Africa, although Messrs. Meldrum have already erected successful installations in Christchurch, N.Z., Annandale (Sydney, N.S.W.), and Toowoomba (Brisbane).

Advance in Rubber Prices.—Since the beginning of the year there has been a material increase in the prices of raw rubber. As an instance of recent advance, the Berlin *Tageblatt* states that at the last auction of india-rubber at Antwerp the prices obtained were from 30s. to 55s. per kilogramme higher than had been estimated, and of 450 tons offered for sale only 16 tons were not disposed of at the time. The scarcity of available supplies, which has brought about the advance in prices, is said to be a consequence of the delay in the harvest in Egypt and India due to unfavourable weather. Apart from Para qualities, which occupy the principal position in the raw rubber market, the irregular quality of most other products from various sources renders a proper knowledge of the article extremely difficult, especially as prices are subject to considerable variations.—*Financial Times*.

Bellows for Dusting Machinery.—The accompanying illustration shows the "Universal" duster and bellows which is being supplied by Herr August Kraushaar, of Hanau a/m: Germany. It is a cylinder dust bellows intended for use in factories, machine

shops, telephone and telegraph establishments. It has no metal mountings, thereby preventing short circuits while cleaning. For cleaning in awkward corners, machines, and any place that cannot be reached by a brush, dust bellows are said to be specially suitable, the compressed air removing all particles of dust from inaccessible places without injuring the articles to be cleaned.

Superheating.—Since the 1st inst., Messrs. Easton and Co. have secured orders for Schmidt, or Bolton, superheater plants for over 7,000 I.H.P., including plant for the Wellington, New Zealand, Electric Tramways.

Catalogues and Lists.—From the Cassel Self-Regulating Water Wheels, Ltd., of 56, Broad Street Avenue, E.C., we have received a copy of their new Pamphlet No. 10. The pamphlet neatly illustrates the different types of the Cassel Constant Speed Water-Weeel which are in actual operation and working under heads ranging from 42 ft. to 1,700 ft. The main feature claimed for this type of wheel is its extremely close speed regulation during all changes of load. Each of the wheels illustrated were furnished under guarantee of a speed variation not to exceed 33 per cent. from full to no load. In the majority of cases, however, a speed variation of not greater than 2 per cent. under these conditions has been obtained. This feature is especially desirable in connection with the driving of electrical machinery.

A small booklet has been received from the Improved Electric Glow Lamp Co., discussing reflector lamps and their uses.

The B.T.H. Co.'s new lists deal with (No. 142) continuous and alternating current fan motors and exhaust fans, (No. 143) type C R feeder regulators.

A new catalogue (dated April) of steel-clad motors has been issued by Messrs. Mather & Platt, Ltd. The firm's steel-clad type of motor is made in five classes:—Open, protected, dust-proof, flame-proof, and entirely enclosed and water-tight.

Mr. Douglas Wells, who is agent for the Continent for the Metallic Seamless Tube Co., of Birmingham, has placed in our hands a catalogue of his tubing for electrical wiring installations. He also represents Messrs. J. Wright & Co., of Tipton, for their Berryman heating and condensing apparatus, Messrs. Mavor & Coulson, Messrs. B. R. Rowland & Co., and other English manufacturers.

An excellent catalogue of power motors has come to hand from the Western Electric Co. Several types of machines are illustrated, encased and semi-encased, open type bi-polars, multipolars, motors for elevator service, back-geared motors and accessories. A large number of first-class pictures show the several types of motors driving machinery of various descriptions. A telegraph code is given.

Messrs. Wm. Harvie & Co., Ltd., of Glasgow, have sent us an illustrated list giving an account of their work in electrical power transmission installations, combined generating sets, motors, haulage plants, switchboards for collieries, shipyards, &c., also ship lights and alarm indicators.

A price list of "Atlas" Leclanché batteries, "Dania" dry cells, zincs, carbon brushes, and other details has been brought out by the Atlas Carbon and Battery Co, Ltd., of Ewer Street, S.E.

Mr. Walter Fox, of Patricroft, Manchester, has sent us several lists of his improved rapid oil filter and capillary syphon oil purifier; also of Bertram Thomas's patent girder clip for cables, piping, &c.

A supplementary sheet of V-type dynamos and motors has been sent to us by the Union Electric Co. It is devoted to small size motors of from ¼ to 1½ h.p. at various speeds from 500 up to 1,700 r.p.m.; both open and enclosed ventilated types are included. A specification of these, and also of the larger V-type machines, accompanies the list.

A second edition, revised and enlarged, of their excellent catalogue of electric overhead travelling cranes, has been brought out by Messrs. Joseph Adamson & Co, of Hyde. The advantages of electric driving for work of this kind are referred to, and general details of parts and construction are also given. The numerous first class pictures illustrate engine and boiler works and other large manufactories where Adamson electric travellers are rendering service, two of the views showing the shops at Messrs. Belliss and Morcom's engine works at Birmingham. A number of efficiency curves of the main hoisting gear of different sizes of cranes are given, a table of tests performed on cranes at Messrs. Yarrow's works, also tests of a Goliath crane at a Shropshire yard. An imposing list appears at the end of the brochure, of the firms for whom Messrs. Adamson have built, or are building, electric cranes with individual motor for each motion.

A circular giving a few illustrations of some of their machine tools has been published by the Pitt Machine Tool Co., of Liversedge.

A new speed-gear list has been received from Messrs. Joseph Baker & Sons, Ltd., of Willesden Junction, N.W. It describes the principles of the Baker gear, the design of which avoids anything leading to excessive friction, heat, or wear. The gear is run in such a way that the teeth engage at a high speed, thereby reducing the pressure on the face of the teeth, and facilitating the use of finer pitches for the transmission of power. By distributing the load to three driving points the strain is so equalised as to relieve pressure upon the journals of the driving mechanism. Slight pressure at a high velocity is thus obtained. Prices and particulars are given in tabulated form, also test curves of a 2-h.p. and 6-h.p. gear. The gear is all made from accurately machine-cut steel castings. It can be driven at the highest possible motor speed. Owing to the balanced drive, all side strain on the driven shaft is avoided and there is no tendency to bind. The patent lubricating device ensures a constant flow of lubricant to all the working surfaces. The motor can be started independently of the gear, and the load gradually put on by the hand-wheel or lever. In the same way the gear can be stopped, and the motor kept always running if desired. It is usually fitted on an extended bedplate with the electric motor, but it can be supplied built attached to and forming part of the motor itself. With any ratio up to 30 to 1 it can be used in a reverse direction to increase speed. In this form it can be successfully employed to couple slow-running engines to dynamos.

Single-Phase Motors.—As the majority of single-phase electric light stations, in towns where there is any demand for power, are now supplying current at 40 or 50 cycles per sec., the Langdon-Davies Motor Co. are issuing a special price list of their motors for these circuits. We note from a copy received that the company are now manufacturing special low-speed motors from 8 b.h.p. and upwards for these circuits, to run at approximately 760 r.p.m. at 40 cycles, and 950 r.p.m. at 50, and also that the prices of the 8 b.h.p. and larger sizes include a graduated starting switch and resistance. Following the invariable design of all Langdon-Davies motors, all these are made without any slip rings, brushes or any rubbing contacts whatsoever, the only wearing parts being the two bearings.

Exports of Electrical Machinery.—The value of the electrical machinery of home manufacture exported from this country during March last is returned at £37,574, and during the first quarter of the year at £113,255.

Dry Cell Litigation.—In view of the recent litigation with regard to dry cells, the subjoined letter from the solicitors of the holders of the Burnley patent will be of interest:—

"To the Universal Battery Co.,
"Mid-Kent Works, Beckenham, S.E.

"Dear Sirs,

"*The Patent Exploitation, Ltd., and Yourselves,*—

"We have pleasure in informing you that we have this day exchanged with your solicitor the agreements between our clients (Patent Exploitation, Ltd.) and yourselves, whereby our clients' claims against you are finally settled, so that no further proceedings will at any time hereafter be taken by our clients against you or against any of your customers in regard to the manufacture or sale or user of any electric dry batteries at any time manufactured by you.

"We are, yours truly,
"(Signed) James, Mellor & Coleman,
"(*Solicitors.*)

"12, Coleman Street, E.C.
"*April 17th*, 1903."

Bankruptcy Proceedings.—A receiving order was made on April 16th, on the petition of a creditor, against Harry South, electrical engineer, of Rathbone Place, London. The first meeting is to be held on May 1st, and the public examination on June 9th, at Carey Street, W.C.

A first dividend of 7s. 6d. in the £ is payable on April 29th, at Birmingham, in *re* J. Worthington & Co., electrical engineers, of Hanley.

A receiving order has been made against G. D. Collins, of Old Road, Frinton-on-Sea, who appears in the directory as consulting electrical engineer and resident engineer, Frinton-on-Sea and District Electric Light and Power Co., Ltd. A meeting of creditors is to be held at Great Eastern Hotel, Liverpool Street, E.C., on Tuesday next, at 11 o'clock. Mr. F. Messent, of 36, Princes Street, Ipswich, is official receiver.

Dissolutions and Liquidations.—The North British Electrical Co. is winding up voluntarily with Mr. J. R. Hesketh, 22, Brazennose Street, Manchester, as liquidator.

The British Aluminium Castings Co. is winding up for purposes of reconstruction with Mr. T. W. Mills, 18, Regent Street, S.W., as liquidator.

A meeting of Stothert & Pitt, Ltd, to be held at Bath on May 18th will hear an account of the winding up from the liquidator.

Creditors of the Pioneer Power Co., of London (in liquidation), must send particulars to the liquidator (F. W. Pixley, 58, Coleman Street, E.C.) by May 28th.

Messrs. G. Warren and C. H. Mathews (Warren & Mathews, gas, electrical, and lighting fittings makers, art metal workers, Longford Street, Regent's Park), have dissolved partnership. Mr. G. Warren attends to debts.

As the notice with reference to the firm of Donnison, Berlyn, Sillem & Co. in our last issue may, through incompleteness, convey an incorrect impression as to the changes which have taken place, we quote from the firm's own circular as follows in order to explain the position:—"The partnership which has heretofore existed between us in the business of electric light engineers, under the style or firm of Donnison, Berlyn, Sillem & Co., has, in consequence of Mr. Berlyn being desirous of making other business arrangements, been dissolved as far as regards Mr. Berlyn; the same business will henceforth be carried on by Messrs. Frederic Akenhead Donnison and William Sillem alone. . . . Mr. Berlyn has consented to act as agent for our firm." The altered name of the firm is Donnison, Sillem & Co.

A meeting of the Electric Insulation Syndicate is to be held at 31, Copthall Avenue, E.C., on May 25th, to hear an account of the winding up from the liquidator (Mr. G. Rae Fraser).

Trade Announcements.—Messrs. J. Marx & Co., of 133—139, Finsbury Pavement, E.C., are now taking sole charge of the United Kingdom business of Mr. J. M. Voith, of Heidenheim, one of whose principal lines is the building of turbines; 246 of these were built at Heidenheim last year. The Voith turbines are made up to 3,000 h.p., the list of purchasers including the more prominent Continental builders of electrical machinery. It is claimed that the Voith precision governors, either mechanical or hydraulic, render it possible to regulate, within exceedingly narrow limits and with great variations of load, thus to a considerable degree ensuring the satisfactory working of the dynamo which the turbine is driving. Another special feature is the Zodel-Voith coupling, combining elasticity and non-conductivity. Messrs. Marx & Co. notify that their agency with Messrs. Hemmer Bros., Ltd., of Neidenfels, has come to an end through the failure of that firm.

Messrs. J. J. Roche & Co., of 83, Queen Victoria Street, E.C., have opened additional works at 13, Little Trinity Lane, E.C., to cope with increased business. The new works are fully equipped for repairing motor and dynamo breakdowns, and a staff is kept for outdoor service.

We understand that the Konstruktionswerke Elektrischer Apparate (System Bertram), of Frankfort, have joined hands with Messrs. Voigt & Haeffner, A.G., from the 1st inst.

The Newcastle-on-Tyne address of the St. Helens Cable Co. is now Imperial Buildings, Westgate Road.

The Lister Electric Manufacturing Co., of Dursley, Gloucestershire, have appointed Messrs. Pinching & Walton, of 52, Cannon Street, E.C., as their sole representatives for London and the South, for the sale of their specialities in dynamos, motors, &c.

Mr. G. D. Seaton, Messrs. Easton & Co.'s Midland Counties representative, has opened an office at No. 49, Deansgate, Manchester, and all communications should in future be sent to him at that address.

Patent Application.—It is proposed to apply for a Bill to continue and confirm patent No. 22,703, of 1898 (amended 1902), granted to W. P. Thompson, acting for F. E. Kip, of Montclair, U.S.A., for "Improvements in stop motions for looms, warping machines, and the like; and for improvements in electrical stop motions for warps." The application is for enabling the above to pay the renewal fees, notwithstanding that the time for so doing has expired, and to deem it as good, valid and effectual as if payments had been properly made.

Electric Steering Gear.—Messrs. Siemens Bros. & Co. have recently fitted a Brougham's patent electric steering gear on board the Earl of Crawford's yacht *Valhalla*. A full description of the apparatus, accompanied by some clear diagrams and an excellent half-tone reproduction, has been prepared by the firm and issued in pamphlet form. We have no doubt that those who take a special interest in the matter can obtain a copy of the pamphlet on application to York Mansion, York Street, Westminster.

Willans Engines.—Messrs. Willans have booked the following orders:—Through Messrs. Mavor & Coulson, from the Aberdeen Corporation, for a 705-H.P. engine for direct coupling to a Mavor & Coulson dynamo, and intended for the Corporation tramways; through Messrs. Bruce Peebles & Co., for an engine of 600 H.P. for driving a Peebles dynamo for the Barnsley tramways; and through the British Electric Plant Co., for a 350-H.P. engine intended for the Corporation of Perth.

For Sale.—Particulars appear in our advertisement pages of a quantity of engineering plant and machinery at Belper, which is offered for sale by tender. Watford Electricity Department is offering scrap metal for sale. Two Crossley gas engines and Crompton and Edmondson dynamos are offered for sale in our advertisement pages to-day. Halifax Corporation offers for sale one 300-KW. single-phase alternator and engine, one 100-KW. alternator, one 100-KW. direct-current dynamo, and one 200-I.H.P. engine; also single-phase transformers. See our "Official Notices" to-day for details.

Books Received.—*Journal of the Institution of Electrical Engineers*, No. 160, Vol. 32 (Part 2). Containing discussion on the "Metrical System of Weights and Measures"; "Notes on Recent Electrical Design," by W. B. Esson; "Notes on the Manufacture of large Dynamos and Alternators," by E. K. Scott; "Design of Continuous Current Dynamos," by H. A. Mavor; also the new wiring rules.

"Electric and Magnetic Circuits," by Ellis H. Crapper, M.I.E.E., London: Edward Arnold. 10s. 6d.

ELECTRIC LIGHT AND POWER NOTES.

Arbroath.—The T.C. has resolved that a committee shall visit Broughty Ferry and inspect the installation there before deciding definitely to work its prov. order.

Barnstaple.—An action is pending against the T.C. in regard to the electric light undertaking, Mr. C. E. R. Chanter raising the point that the Council has exceeded its powers by carrying out wiring and fitting up consumers' premises. The Council met yesterday to consider whether a mutual arrangement could be arrived at, but ultimately decided on defending the action.

Basingstoke.—The Council has decided in favour of leasing its electric lighting order to Messrs. Edmundson's Electricity Corporation, whose terms are that the Council shall provide the capital, the company erecting the buildings and providing the plant under the supervision of the Council's engineer, and paying as rent a sum equal to the interest and redemption of the loan; the Council to have the option of taking over the undertaking as a going concern on terms to be agreed on at the end of 7, 14 or 21 years. Mr. R. P. Wilson, the Council's consulting engineer, had previously submitted a scheme for electric lighting and pumping at the sewerage works, at an estimated cost of £18,000, and a supplemental report advising the Council not to dispose of its prov. order.

Berwick.—A deputation from the T.C. has visited Hawick for the purpose of inspecting the lighting of the streets with electric light. The Urban Electric Supply Co., who have the lighting of Hawick and Berwick, have made the latter Corporation an offer for the lighting of the streets on similar lines to the Hawick installation, which has given great satisfaction.

Bo'ness.—The T.C. has come to an agreement with the National Electric Wiring Co. to carry out its prov. order for lighting. Under the agreement the premium payable to the company on the cost of the works, plant, &c., has been modified to 7 per cent. The maximum prices are:—For private lighting on the maximum demand system, 7d. and 3d. per Board of Trade unit, or 5½d. flat rate; for power and heating, 3d. and 2d.; for streets and public buildings, 2½d. The lease is for 10, 14, 17 and 20 years at the option of the Council. The company have to pay interest and sinking fund on the Council's loan at 6 per cent., if the period for which the loan is granted does not exceed 30 years. The company are prepared to find the capital for the buildings, to commence operations by July 1st, and to have the light turned on in certain parts of the burgh by Christmas.

Bracebridge.—The Visitors of the County Lunatic Asylum at Bracebridge have appointed Mr. Vesey Brown to carry out the electric light installation at the Asylum.

Brighton.—The T.C. has applied to the L.G.B. for a loan of £1,100 to defray the cost of installing the electric light in the interior of the Aquarium.

Cashel.—The U.D.C. has decided to advertise for a consulting engineer to advise the Council on the electric lighting question.

Cheltenham.—A L.G.B. inquiry was held on Friday into the application of the T.C. for a loan of £14,000 for electric light extensions and arc lighting. It was stated that the gross profit on the undertaking for the present year was £8,000, which would go to the interest and sinking fund. There was no opposition.

Chester.—The Lighting Committee has recommended that application be made to the Local Government Board for sanction to borrow the further sum of £14,076 (making with £105,924, the amount already borrowed, a total of £120,000), for extending the electric light undertaking.

Crieff.—The Town Council has had under consideration the advisability of lighting the town by electricity, and the Lighting Committee has been empowered, if it think fit, to advertise for offers from electric light companies which will be laid before the Council.

Calverley.—The B. of T. has granted a prov. order for electric lighting to the U.D.C.

Dover.—Mr. Parshall, the second expert employed by the T.C. to report upon the undertaking of the Dover Electric Lighting Co., which the Corporation has agreed to purchase, recommends that the purchase price, £142,228, is a reasonable one, and advantageous to the Council.

Dunfermline.—The National Electric Wiring Co. has informed the T.C. of its intention to apply for a prov. order for the electric lighting of the town, and to provide a tramway scheme for the district. There is a probability of a local company being formed for the same purpose.

Falkirk.—The T.C. has decided that, unless the terms of the order to be sought by the Scottish Central Electric Power Co. are modified, it will oppose the application, and a committee has been appointed to co-operate with Stirling, Alloa and other places that may be affected by the order.

Germany.—The Dessau Gas Co. has decided to establish a central electric lighting station in connection with the gasworks at Hagen-Eckesey.

Gravesend.—The T.C. has adopted the following charges for electricity:—Arc lamps, 3d. per unit; motive purposes, 2d. per unit; lighting Corporation offices, &c., flat rate of 6d. per unit.

Hastings.—The T.C. has received from the L.G.B. sanction to borrow £705 for electric lighting purposes.

London.—Bethnal Green.—The Electricity Committee of the B.C. has resolved to purchase land for the purpose of building an electricity generating station and refuse destructor.

Bermondsey.—At Tuesday's meeting of the Borough Council, it was reported that up to date 5,554 8-C.P. lamps had been applied for in excess of the capacity of the present plant.

Poplar.—The Electricity Committee of the B.C. considered this week the chances of a failure in the supply next winter in consequence of the Council refusing to sanction the suggested extensions of plant. The Committee recommends that three spare armatures complete with shaft and half coupling, be obtained from Messrs. Mather & Platt at a cost of £907.

Nairn.—The T.C., in reply to correspondence from Messrs. Crompton & Co., London, stating that the Council's amended agreement was unacceptable to them, has agreed to enter into further negotiations with Messrs. Crompton, asking them to state their objections, and advise as to their most favourable terms. Messrs. Crompton object to the conditions as to the purchase price of the lighting, the extension of the lighting area, and the completion of the works.

Nottingham.—The competition between the Gas and the Electricity Departments of the Corporation is becoming interesting. Recently the Gas Committee decided to reduce the price of gas for power purposes from 2s. 10d. per 1,000 cb. ft. to 1s. 6d. or 1s. 8d., according to the quantity used. This makes the price of gas about 1d. for 2½ H.P. an hour, while electricity costs 1d. per unit. It is estimated that there are at present 600 gas engines at work in the city. The Gas Department themselves have between 30 and 40 gas engines working, and a large engineering firm who are building new works in Nottingham are providing for their power on the same system. The prospects of the gas engine in the lace city certainly appear very rosy.

Paisley.—The E.L.C. has recommended for acceptance the offer for engine and Schuckert alternator by Messrs. Davey, Paxman and Co., being a duplicate of the existing 300-KW. alternator, at the price of £2,400. At next meeting will be submitted a statement of the probable cost, along with plans, of new buildings proposed to be erected for the accommodation of additional plant.

Romford.—The Empire Electric Light and Power Co. is applying for leave to amend its Bill relating to the terms of taking over the U.D.C.'s electric lighting order, so as to extend the period for laying mains, alter the period for municipal purchase, &c.

Rugby.—The E.L. Committee of the U.D.C. has adopted a scheme for wiring private houses, the occupants either purchasing or renting the installations, which will be carried out by local contractors under the Council's supervision. Motors are also to be hired out. The price to be charged for light will be 5½d. per B.T.U. It is expected that the supply will be available in August.

Swanage.—At a meeting of the U.D.C., held on April 14th, a letter was read from the Sir Hiram Maxim's Electrical and Engineering Co., Ltd., asking details of the Council's requirements in regard to electric lighting. It was resolved to ask Sir Hiram Maxim & Co. to furnish the names of any U.D.C.'s they have supplied with electric installations, and whether they obtained the order or the Urban District Council, and stating

that the Council is desirous of adopting a scheme if it can be shown it is a paying concern for an increasing town with a population of about 4,000.

Woking.—The Woking Electric Light Co. report a satisfactory year with a large increase in consumers; they are concluding a contract with the L. and S.W.R. Co. for the lighting of Woking Station and the goods yard, a contract which represents some 70,000 units per annum.

ELECTRIC TRACTION NOTES.

Bolton.—The Corporation has just closed a successful year's working. The gross profits of the tramways amounted to £38,515. The traffic receipts were £85,703, as against £78,036 in the previous year. A sum of £22,790 has been allocated to depreciation, and £4,966 in aid of the borough rate.

Dewsbury.—The Halifax Road section of the B.E.T. Co.'s tramway system at Dewsbury was opened on Saturday. But for a dispute with the Batley Corporation it is probable that ere now there would have been a through line along this road from Dewsbury to Spen Valley. It is now suggested that matters have so far been arranged that the company will at an early date be able to proceed with the laying of the lines through the Batley borough and thus connect the Dewsbury and Spen Valley lines. Trial cars have already been run from Heckmondwike to Cleckheaton (Spen Valley), and it is expected that the official inspection of this section will take place shortly. The Thornhill and Ravensthorpe sections from Dewsbury have so far been very well patronised.

Manchester.—The success of the first year's working of this tramway has been greater than the promoters of the undertaking anticipated. It is stated that from the past financial year's surplus, after paying all liabilities, the Tramways Committee was able to hand over a sum of £30,000 in reduction of the rates. In the current year the amount of profits to be similarly applied is estimated at £50,000. The income for the 12 months ending March, 1904, is estimated at £537,699, and after the working expenditure has been deducted from this, there remains a gross estimated surplus for the year of £184,820, of which it is proposed to apply £24,566 to sinking funds, £48,254 loans and interest, and £18,000 for depreciation and reserve fund, and £44,000 on permanent way account, besides the £50,000 for relief of rates. The renewal and depreciation funds are being kept on a sound basis. The amount devoted to them has been increased from £36,249 last year to £62,000. Last year's estimate of income was £263,036, and this was exceeded by the actual receipts by not less than £57,000. On capital account the estimated expenditure for the current year is £428,890, as against an actual expenditure last year of £580,628. The receipts from the tramways during the week ending April 11th reached a total of £12,063, or some £2,000 more than had been recorded for any previous week. The number of passengers carried was close upon 2½ millions. These figures include the takings for a full week on several new routes, but not those on the Stretford extension, which was only opened on Bank Holiday.

Melbourne (Vic.) Railways.—It was proposed last month that Mr. Tait, the new Commissioner of Railways, be directed, when in America, to make inquiries into the question of electric railway traction, especially in relation to suburban traffic. The proposal came from the Railways Standing Committee, who suggested inquiries as to whether any American steam railways had been converted to electric traction; whether overhead wire or third rail was employed; and as to the extent of water-power utilisation in connection with such undertakings; the maximum distance electricity is economically transmitted for moving passenger cars or freight trains, and the type of power station machinery. The use of petrol automobile cars on rails as feeders to suburban railways, or country lines where traffic is light, was also stated among the points suggested for investigation.

Nottingham.—Operations are to be renewed within the next few days in connection with the tramway sections next on the list for extension upon the Corporation system. The standards which will carry the electric wires in Market Street have already been erected. The Hartley Road section has been delayed owing to the fact that the Corporation has had to wait for the points, crossings and junctions which are being constructed at Sheffield. The junction required at the Alfreton Road end is coming from America, and this is expected to arrive in the course of next week. It is hoped to have this section ready for traffic in about a month. The Market Street line will be rather a formidable undertaking. All the curves round which the trams now pass to the eastern and western sections will have to be taken up, and the work at this spot entirely reconstructed so that cars from both directions may, if desired, turn up Market Street, the object being to provide for the re-arrangement of the Chapel Bar traffic. The last-named thoroughfare is to be used as a down road only.

On Monday a company of city officials and prominent citizens witnessed a demonstration of rail-jointing by the "Thermit" process. The process is shortly to be used on the electric tramway extension in Hartley Road.

The trolley of a car slipped the wire and fouled in a V-shaped fork at the junction of the Nottingham Road and Sherwood lines. In the result the trolley pole and standard were wrenched out, the plank to which the standard was bolted severely injuring in its upward flight the face of a lady passenger. It is curious that the wire itself was not broken by the strain, as that is more nearly what one would expect to occur if the trolley-head did not come off the pole.

Paisley.—The Town Council has been in communication with the Glasgow Town Council with the view of ascertaining how many cars the City Corporation expects to have running on the section between Hawkhead Road and Paisley Cross. The reply was that for ordinary service the number would be seven, but that on holidays and such occasions the number might be considerably increased. The question of supplying current for these cars was thereafter considered by the Electric Lighting Committee of the Paisley Council, and they were of opinion that it would not be expedient to entertain the proposal.

Rowley.—The U.D.C. before proceeding with the construction of the electric tramway from Old Hill to Blackheath has decided to interview the Midland Tramway Co. at Birmingham, so that the work may go on amicably as between the company and the Council.

Wednesbury.—The Mayor of the borough has had an interview with representatives of the British Electric Traction Co. with the result that the differences which have for some time existed between the company and the Corporation have been amicably settled. The leases of the tramway lines in the borough having expired new terms had to be arranged, and it was on this point that the hitch which led to a prolonged deadlock occurred. The work of electrically equipping the lines will now be immediately proceeded with.

Wolverhampton.—A meeting of the Tramways Committee has been convened for to-day (Friday), when it is expected a definite decision will be arrived at respecting Mr. Shawfield's report. The reproduction in the columns of the *Express and Star* of the article "Nemesis," from the Electrical Review, has had the effect of chastening, so to speak, the extreme advocates of the Lorain system, and councillors now feel that a very grave responsibility rests upon them. "So far, however, as the feeling of the public can be gauged," says our local correspondent, "it is quite evident that they are greatly enamoured of that system, and that they will be disappointed if anything should arise to permanently upset it. They totally disregard the high rates, and the prospect of these being increased, they will not listen to any arguments based on the question of the 'isolation' of the borough, the lack of effective intercommunication with the outside districts, or the fact that the increasing local imposts may have the effect eventually of driving manufacturers away from the borough. It seems to be sufficient for some of them that the town possesses a system of tramways such as is not to be found anywhere else, and therefore, they are prepared to stick to it. Attempts are being made to discredit the Electrical Review by hinting that it is in some mysterious way influenced by the British Electric Traction Co., but these attempts are, of course, unavailing among the more intelligent section of the community." Complaint has been made that Mr. Shawfield's tabulated statement as to the earnings of the tramways did not go beyond the month of January, which showed a loss of £127 4s. 3d. Though we are now nearing the end of April, no official attempt has been made to bring the return up to date by the inclusion of 11 instead of 9 months. In order to get some approximate idea as to how things stand, the weekly returns for the present year have been analysed. It is found that in February the total receipts from passengers amounted to £1,616 12s. 2½d. To this must be added £30 revenue from advertisements, and about £5 from parcels, making a total income of £1,651 12s. 2½d. The number of car-miles run was 42,581. The average cost per car-mile during the preceding nine months was 10·737d., or nearly 11d., but as the cost seems during the last four months to have got down from 10·82d. to between 9d. and 10d., 9d. has been taken as the standard in this calculation. On this basis the cost works out at £1,596 15s. 9d., giving a profit of £54 16s. 5½d. The figures for March are:—Receipts, £1,650 18s. 8d.; cost, £1,594 12s. 3d; profit, £56 6s. 5d. The figures for the first two weeks of April on the same basis are:—Receipts, £858 12s. 9d.; cost, £775 0s. 3d.; profits, £83 12s. 6d. The net result of the 10 weeks' working is thus £194 15s. 4½d. It should be remembered that there are several items of cost which have not been allowed for in the official statement nor in this calculation, and it must also be taken into account that the cost per car-mile has never yet been got down to 9d., fluctuating near 9½d. It is more than probable, however, that when the official statement is issued, it will be found that the cost per car-mile has been nearer 10d. than 9d. In this case there would be no chance of any profit whatever. It is also regarded as very significant that immediately after the close of the Exhibition—during the running of which the traffic was greatly inflated—the profits began to disappear. The gravest aspect of the whole question, however, is that a section of the Tramways Committee have so committed themselves to the system, that even if the Council desired to abandon it, it would be impossible, in face of Clause 19 of the contract, to do so. In the Committee members are acutely divided, and whatever decision is finally arrived at, there are almost certain to be resignations; and it is stated that several members of the Council who originally voted for the Lorain system are now prepared to vote against it.

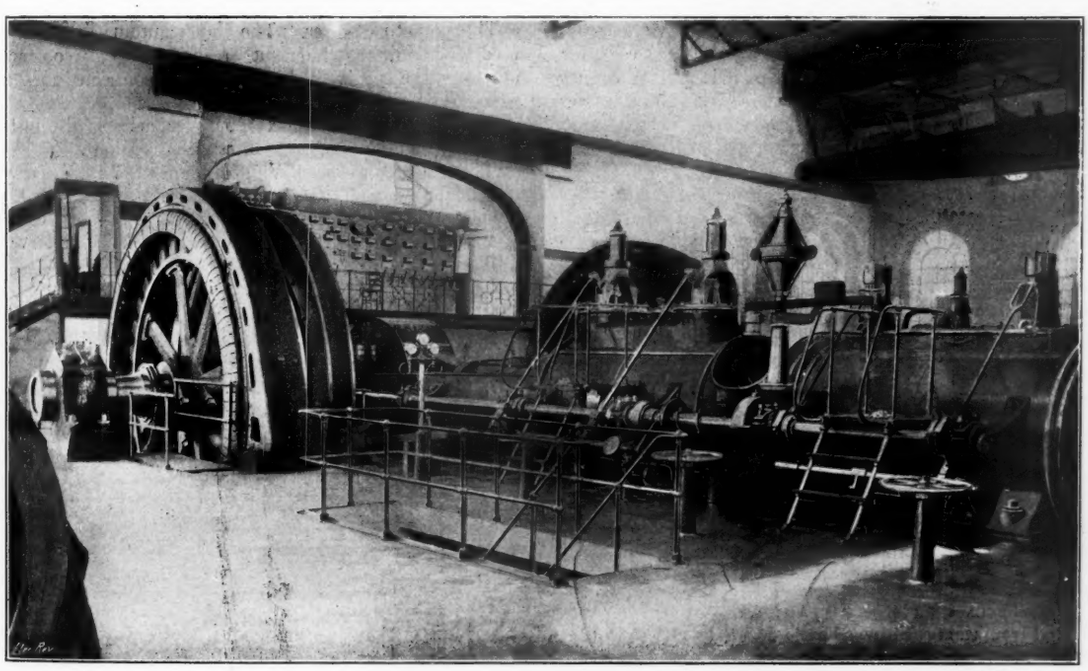
(*Continued on page* 703.)

THE MILAN-VARESE-PORTO CERESIO ELECTRIC RAILWAY.

The first section of Italian railway line to be equipped with electrical traction was that which connected the towns of Gallarate, Varese and Porto Ceresio with Milan; this line forms part of the railway system of the Società Italiana per le Strade Ferrate del Mediterraneo, and not only carries a heavy tourist traffic on account of its contact with Lakes Maggiore and Lugano, but also forms the main artery between Milan and one of the most industrious and densely populated districts of Italy. As will be seen on reference to the adjoining map, the portion of the system already electrified extends from Milan to Porto Ceresio, on Lake Lugano; the other branches shown, to Laveno and Arona, on Lake Maggiore, are in process of conversion, and will be electrically operated at an early date. The railway company was induced to undertake the conversion by the density of the traffic over the lines in question, combined with the heavy cost of coal, the original intention being to utilise a fall on the River Ticino; however, owing to the variable quantity of water available, steam-driven generating plant could not be dispensed with, and it was thought better to adopt steam entirely than to incur a heavy capital expenditure on a duplicate hydraulic plant. This decision was strengthened by difficulties met with in the course of negotiations for the concession of the water-power.

Map of Route.

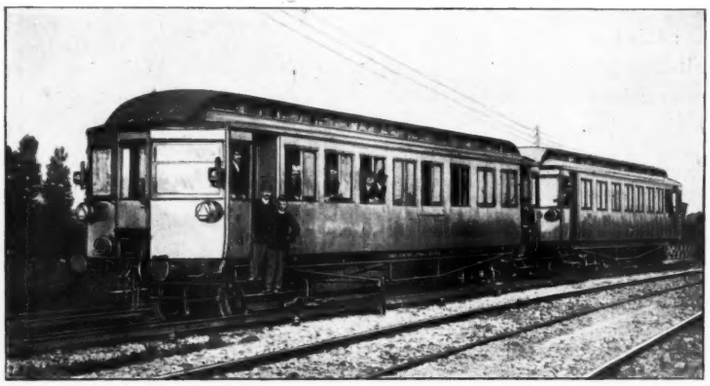
The generating station, as shown on the map, is situated at Tornavento, on the River Ticino, about seven miles from Gallarate; from the power station the mains are carried across country to Gallarate and Parabiago, after which they follow the course of the railway lines, feeding converting sub-stations at Gallarate, Gazzada and Bisuschio on the north, Parabiago and Musocco on the south. The current is conveyed to the trains by means of the "third rail." The trains consist usually of two cars each, a motor-car and a trailer, seating 76 passengers, making a total capacity of 152 passengers per train. The distance of 25 miles between Milan and Gallarate is traversed by express trains in 30 minutes; and the motors are capable of giving a speed of over 60 miles an hour. The total length of the line is 47 miles, of which the part between Milan and Gallarate is double track. Electrical working between Milan and Varese was commenced in November, 1901, and was extended to Porto Ceresio in June last year. The whole of the electrical equipment, including the plant at the generating station, was installed by the Compagnie Thomson-Houston de la Méditerranée, while the steam engines and boilers at the power station were supplied by Signor Franco Tosi, of Legnano.



View of Steam Alternator and Main Switchboard at Tornavento.

The steam generating plant consists of eight water-tube boilers, of 290 m². heating surface each, working at a pressure of 12 atmospheres, and fired by hand; there are also three sets of economisers. In the engine room there are three generating sets, each comprising a horizontal tandem compound one-crank engine coupled to a three-phase alternator. The engines are fitted with the Franco Tosi valve gear, the admission valves on the high-pressure cylinder being operated by trip gear controlled by the governor, while

those on the low-pressure cylinder are positively operated. Each engine has a normal output of 1,200 B.H.P., and a maximum of 2,000 H.P. at 94 r.p.m., with steam at a pressure of 11 atmospheres. Between the engine and the generator there is mounted a heavy fly-wheel.



View of Motor-Car and Trailer.

The alternators are of the revolving magnet type, rated at 750 KW. each, and generating at 13,000 volts three-phase; they are capable of an overload of 25 per cent. for two hours, and 40 per cent. for short periods. The magnet wheel carries 32 poles, giving a frequency of 25 cycles per second.

The alternators are excited by means of two 75-KW. dynamos, driven by vertical engines and generating at 125 volts.

The switchboard consists of nine panels, of which three are for the generators, one for the exciters, one for the total output meters, and four for the transmission lines. Transformers are interposed between the high pressure lines and the instruments on the switchboard, so that there is no danger to the attendants in operating the latter, and the connections with the alternators and lines are kept out of reach. An oil switch capable of interrupting the current at 13,000 volts is interposed in circuit with each alternator, and each of the transmission lines is brought in through an automatic oil circuit-breaker, specially designed for this installation; the latter are placed about 5 ft. behind the switchboard, in incombustible boxes, and are operated from the board by means of levers. An installation of Wurts lightning arresters is provided.

The four high pressure lines leave the station on the same poles, but soon separate, as indicated on the map; two lines run northward and two to the south, each set being composed of six copper wires carried by special insulators on wooden poles. The diameter of the wire varies between 4 and 9 mm., and the total length of line is 51 miles. The poles are spaced at intervals of 130 ft., and in some parts every tenth pole is of iron. A spare line joins the sub-stations of Parabiago and Gallarate. All the lines are protected with lightning arresters, and equipped with oil switches where they enter the sub-stations.

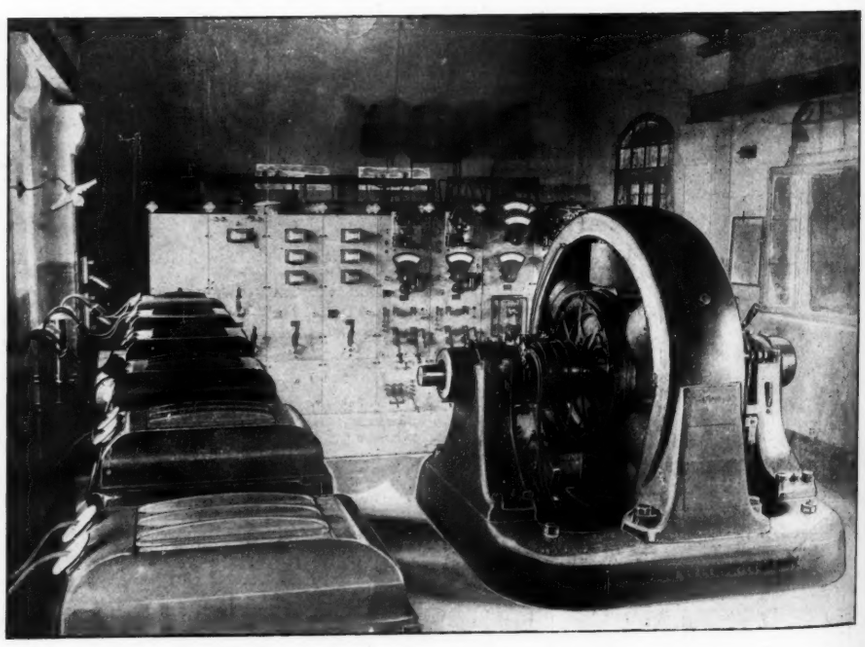
The sub-stations are on the average about 10 miles apart; the three nearer Milan are equipped with two six-pole compound-wound 500-KW. rotary converters each, the other two having one 250-KW. rotary each. In each of the larger sub-stations there are seven transformers, cooled by an air-blast, of 180 KW. each, one being held in reserve; these reduce the pressure to 420 volts, from which the rotary converters give direct current at 650 volts. Provision is made for starting the rotaries from either the direct or the alternating side, the field magnet circuit being sub-divided in the latter case. The converters are capable of an output of 40 per cent. above their normal rating, and either of them can maintain the ordinary train service in case of a breakdown of the other. The transformers are used in two separate groups, one for each converter. The switchboards, as in the power station, carry no high-pressure apparatus. The direct-current panels are provided with magnetic blow-out circuit breakers, and the usual standard apparatus of the Thomson-Houston Co.

The other two sub-stations are similarly equipped, but have only one converter each, and as the load in these stations is very variable, they are, in addition, provided each with a buffer battery of 323 cells, of 320 ampere-hours' capacity discharging in one hour, and a Thury motor-booster. The Thury automatic regulator is used to maintain the output of the converter constant at all times, the battery and booster being connected in parallel with the converter.

A battery of 505 ampere-hours' capacity is also installed in the sub-station at Musocco, nearest to Milan.

The track consists of Vignoles rails of 72 lbs. per yard, carried on wooden sleepers. The joints are bonded with copper wire 11 mm. in diameter, with cross-connections of similar wire between the rails and tracks at intervals of 110 yards.

The third rail or conductor is a Vignoles rail weighing 90 lbs. per yard, and is carried on insulators at the side of the track at intervals of about 13 ft. The insulators are of artificial granite, which has been found to answer well; over the granite there is an iron cap, on which the rail is carried, with freedom to move slightly with temperature variations and bending of the sleepers as the trains pass over them. Other types of insulator are also under test. The joints are bonded with flexible copper bonds of 200 mm². cross-section. The electrical resistance of the third rail,



Interior of Sub-Station.

including bonds, is about 0·05 ohm per mile. The average loss by leakage at the insulators varies from 0·16 to 0·2 ampere per mile of third rail, according to the weather. On gradients the rails are firmly connected in lengths of 10, and are anchored at the middle

Locomotive, Train, and Transmission Line Crossing Railway.

point; these lengths are connected by flexible couplings. At points and level crossings the conductor rails are interrupted, the circuit being then completed through armoured cables of 400 mm². cross-section. The conductor is shielded to some extent from accidental contact by a wooden roof, as shown in the figures.

No feeders are used along the railway, the conductors being fed direct from the sub-stations; the conductors are cut at each sub-station, and the two open ends are connected at the switchboard. As all the sub-stations are in parallel on the contact rail, in case of an interruption of the high pressure feeders, the converters would take current from the rail and run as direct-current motors, with the series winding in opposition to the shunt; to prevent this dangerous possibility, reverse current cut-outs have been provided which break the circuit if the current tends to reverse.

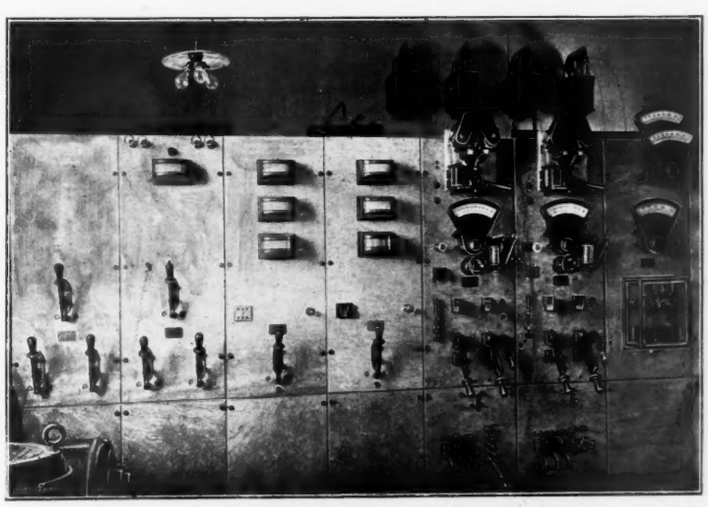
The rolling stock consists of 20 motor-cars and 20 trailers of the corridor type, entered at the ends; the former weigh 40 tons each and the latter about 25 tons, and both measure nearly 60 ft. over the buffers.

The body of each car is supported by two bogies, the axles of which, in the case of the motor-cars, are direct driven by motors. These are of the type G.E.—55, four to each car of 165 H.P. each, and are designed for a speed of 55 to 60 miles per hour, which is required for the greater part of the journey between Milan and Gallarate, with rapid acceleration from rest. There are two L-3 series-parallel controllers on each car, each controlling the four motors, together with the usual switches, circuit-breakers, &c. Besides a hand-operated brake, there is an air brake for which, and for the whistle, a 4-H.P. motor-compressor is provided. Glow lamps in series are used for the head and tail lights and for lighting the interior of the cars. The current is collected from the third rail by shoes at each end of the car, supported from the grease boxes by iron brackets (see fig. on p. 702); contact with the rail is thus maintained by one or other of the shoes, even where wide gaps in the rail occur. The maximum current at starting is 700 amperes, and in normal running 600 amperes; the drop of pressure on the line is about 15 per cent.

An electric locomotive for hauling goods wagons is shown in one of our views; this weighs 34½ tons, and is equipped with four GE. 55 motors of 165 H.P. each, a central series-parallel controller, type L-7, air-compressor, &c.

16 bogie cars are in course of construction, two of which are being arranged on the "multiple unit" system, as well as five bogie vans for goods and mails.

The traffic has at times become so heavy that 86 electric trains have been run in one day, all of them heavier than the normal, and the management was hard put to find sufficient rolling stock to cope with the demand; in fact, it became necessary to run four steam trains in addition. The latter, however, were not appreciated by the travellers, who often preferred to wait for an electric train. According to a report of the railway company, very few drawbacks have been met with in the working of the system, and those were of little moment, while the public has shown its appreciation of the innovation in the most unmistakable manner. During one year the electric trains performed nearly seven million car-miles as compared with three millions with steam haulage, and the total receipts between December 1st, 1901, and August 31st, 1902, in spite of a reduction in the fares, rose to 993,150 lire, as compared with 663,000 lire in the corresponding period of the previous year. On the occasion of a festival at least three times as many passengers were carried as at the same time in the previous year. These figures will serve to show the popularity of the new system, which has, indeed, everything in its favour; cleanliness, high speed, frequency of service, reduced fares, all are attractions of considerable commercial value. We trust that those of our British railway managers who have not already done so, will take note of the success attained, and that they will lose no time in emulating it. Experiments are not necessary when object lessons such as this are displayed before us.



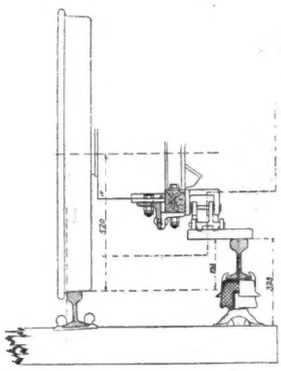
Main Switchboard in Sub-station.

The Cancer Research Committee and High-frequency Currents.—The *New York Herald* (Paris edition) some days ago published a dispatch from its Berlin correspondent stating that the leading German surgeons and authorities on cancer interviewed by him all discredit the report of the British Cancer Research Committee that the disease can be cured through the high-frequency electrical treatment. Experiments with electricity have been made by the leading German authorities for ten years, according to Prof. Bergmann, and have been abandoned as impracticable. Prof. Bergmann said: "It is folly to believe that a cancerous growth can be destroyed by high-frequency electric current. From 20 to 30 per cent. of the cures are now effected by means of the knife and we believe that surgical treatment is the only one practicable and at the same time the most humane. England must be commended on the great progress she has made in investigating the genesis and the curative treatment of cancer, but I do not believe electricity will be applicable." Prof. Leyden, the chairman of the German Commission, and Prof. Rosenbaum expressed similar views.

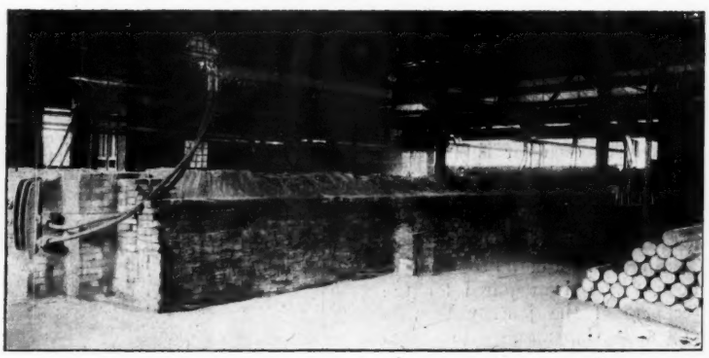
SILOXICON.

Mr. Orrin E. Dunlap writes:—"A new refractory material, which is to be called 'Siloxicon,' has been discovered by Mr. E. G. Acheson, of Niagara Falls. Mr. Acheson is the discoverer of the processes for the manufacture of carborundum and artificial graphite, but it is his opinion that his latest discovery is destined to be even more important to the industrial world than either of the processes referred to. 'Siloxicon' is made in an electrical furnace in a manner somewhat similar to carborundum and graphite. The raw materials are ground coke and sand, to which may be added sawdust to increase the porosity of the mixture. The furnace in which siloxicon is manufactured at present is erected in the plant of the International Acheson Graphite Co. It is built of loose brick, no mortar being used. In length the furnace is about 30 ft., and it is 8 ft. wide and 6 ft. high. 1,000 E.H.P. is used in its operation. It is Mr. Acheson's discovery that the manufacture of siloxicon requires that the temperature of the furnace be kept below that necessary for the manufacture of carborundum. Siloxicon forms when the temperature of the furnace is maintained at a value ranging from 4,500° to 5,000° F., while carborundum requires a heat verging on 7,000° for its manufacture. In colour siloxicon is grey-green, and when it comes from the furnace it forms a loosely coherent mass. It is reduced to powder form, so that it will pass through a No. 40 sieve, by running it through a mill. In its powdered form it is shipped in barrels. Siloxicon is a self-binding material, and when moistened with water it can be formed into any desired shape and fired. However, for many purposes, it will be mixed with about 25 per cent. of clay. The prospective field that will be occupied by siloxicon is in the manufacture of refractory linings for furnaces or converters, the manufacture of crucibles, fire-brick, muffles, tuyeres, &c. In every way siloxicon is a substitute for refractory clays, magnesia, lime and graphite in their application to high temperatures. Siloxicon is insoluble in metals, infusible at high temperatures, and is inert toward both acid and basic slags. Crucibles made of siloxicon are found to be superior to the crucibles of clay or of graphite and clay in common use in that they are not acted upon by the molten metal or worn away externally by the action of fuel or furnace gases. While Mr. Acheson considers it preferable to utilise the self-binding properties of siloxicon in its various applications to articles or linings, he realises that in some instances it may be preferable to use a binding agent, such, for instance, as hydro-carbons, as liquid tar, asphaltum or pitch, carbonaceous materials, as molasses or glue, or other agents. When a permanent binding agent is used, like liquid tar, the ground siloxicon and sufficient tar to bind it together are mixed thoroughly in a hot condition, the resultant mass being moulded into the desired forms, which may then be burned, or they may be used without burning, in which case they receive the necessary burning while in their permanent combination. It is pointed out that when siloxicon is used as a furnace lining, it may be preferable to prepare the mixture as when making articles and tap or ram it into place. The new Niagara furnace in which siloxicon is made, is protected by recent patents granted to Mr. Acheson. It has a double flat core, but as Mr. Acheson's patents cover a plurality of cores, it is likely that future furnaces will have three cores. The adjoining illustration gives a good idea of the size and shape of the furnace."

Milan Railway: Level Crossing, showing Switch-Box.



Milan Railway: Arrangement of Collector.



Furnace used in the Manufacture of Siloxicon.

Harvesting by Electric Power.—Mr. Hamilton Wright, in the *American Electrician*, gives an account of a method of using electric power which has been developed in the San Joaquin Valley, California, and is considered likely to revolutionise present methods of harvesting grain on a vast scale. He states that it has been successfully demonstrated that a combined harvester and thresher with electricity as its motive power will perform the work of a 60-H.P. traction engine at one-fifth the cost for power alone, and one-half the cost for total operating expenses. A large dynamo was recently set up on a dismantled traction engine, electrical connection being provided by an insulated cable which was paid out from a reel as the machine advanced, the dynamo being used as a motor to propel the traction engine. When current was admitted to the motor the big machine started away without a hitch, drawing a combined harvester at a rate sufficient to cut and thresh 85 acres of standing grain a day. A similar harvester drawn by 41 horses would cut an average of 60 acres a day at almost three times the total cost of operating. In the great wheat fields of the Pacific Coast, however, steam has almost entirely superseded animal power. Now electricity bids fair to take the place of steam. A strong feature of the electrically-driven combined harvester and thresher is that with it four men may produce results which have hitherto required the services of a dozen. A motorman, a steerer, a sack-sewer and a general attendant easily attended to the big harvester on its trial trip. Doubtless when a greater degree of perfection in this method is attained three men will suffice, the motorman also steering the machine. It is obvious that an electric traction engine could also haul a harrow, plow, sower, cultivator, &c., and do the work of steam machines built for the various agricultural operations. A fact perhaps not yet realised is that irrigation and generation of power from the fall of water go together. Not a single drop of water is lost by the utilisation of its gravity, and when the water issues from the turbine of a power house it may be diverted to agriculture. Thus the water which is used to irrigate the land may also furnish power to harvest the crops. It is estimated that the running streams of California alone will supply 840,000 H.P. Of this amount the fairly large quantity of 125,000 H.P. has already been utilised.

Water Power in South Africa.—In the current *Cassier's Magazine* Mr. Francis Fox discusses the utilisation of the Victoria Falls on the Zambesi River. It is estimated that in the wet season 35,000,000 H.P. is running to waste, or about five times the power in the Niagara Falls. In a new country like Rhodesia, with its gold, copper, and coal mines there is an enormous demand for power, and the establishment of a water-power electric station near the Falls would attract chemical and metallurgical industries as has happened at Niagara. The power house would be placed in the second zigzag below the Cascade, where a head of at least 250 ft. could be obtained. An 8-ft. pipe would serve a 5,000-H.P. generator, which is probably the size of unit that would be adopted.

ELECTRIC TRACTION NOTES.

(*Continued from page* 698.)

Grays.—Steps are being taken by a syndicate to obtain powers to construct electric tramways from Grays to Tilbury and Purfleet. A survey of the suggested route has been made, and the support of the local authorities is being sought.

Huddersfield.—The manager of the Corporation tramways has been instructed to obtain chilled car wheels from Messrs. Milnes, Voss & Co., at £1 10s. 9d. per wheel. The manager has also been authorised to offer the British Electrical Car Co. £430 for an "Exhibition" car, which offer has been accepted.

In reference to the Dewsbury, Batley, and Birstal Tramways, the town clerk has reported to the Tramways Committee the suggestions made by the Mirfield U.D.C., as to the negotiations now proceeding with the British Electric Traction Co, with respect to the question of widening bridges, and the Town Clerk (Mr. J. H. Field) was authorised to proceed with the transfer of the Corporation's powers. The town clerk has been instructed to request the borough member (Sir Jas. T. Woodhouse), and the county member (Sir Jas. Kitson, Bart.), to oppose the the Tramway Workers' (Hours of Labour) Bill, 1903.

The cost of the Moldgreen accident was reported to be £3,396 11s. 11d., and the Committee have resolved to transfer this sum from the depreciation account to the year's revenue account.

At a meeting of the Tramways Committee on 9th inst. the borough treasurer submitted a statement of the tramways revenue account for the year ended March 31st, 1903, showing a balance deficiency of £12,136 9s., which, added to the balance of £9,036 3s. 8d. brought forward from last year, made a total debit balance of £21,172 12s. 8d. It was resolved that the Finance Committee be requested to make provision in the new borough rate for a rate in aid of the tramways of 7d. in the pound. The depreciation account showed a balance in hand amounting to £16,445, and the compensation account a balance of £245.

At a meeting of the Borough Council on 15th inst. the recommendation of the Committee was adopted. The details of the accounts are as follows:—

Amount of deficiency for year ended March 31st, 1901	£10,100	4	8
Deduct amount transferred from depreciation account	5,000	0	0
Leaving balance carried forward	£5,100	4	8
Add deficiency for year ended March 31st, 1902	9,144	19	0
	£14,245	3	8
Deduct amount of rate in aid equal to 8d. in the £ ..	5,209	0	0
Balance carried forward	£9,036	3	8
Deficiency for year ended March 31st, 1903 .. £8,739 17 1			
Add cost of Almondbury accident, June 28th, 1902 3,396 11 11			
	12,136	9	0
Present debit balance, to be dealt with by rate in aid or otherwise	£21,172	12	8

Steam Section.—Receipts, £2,554 16s. 4d.; miles run, 47,817; per mile, 12·82d. Total expenditure, £3,122 8s. 3d.

Electric Traction.—Receipts, £54,076 12s. 10d.; miles run, 1,274,112; per mile, 10·18d. The total expenditure amounted to £65,645 9s. 11d., showing a loss of 2·19d. On both sections the deficiency was £12,136 9s.

The tramway receipts for the month of March last amounted to £4,786 2s., an increase of £607 19s. 10d. upon the corresponding month of the previous year. The receipts are equal to 9·05d. per car-mile.

Liverpool.—The Traffic Sub-Committee has entered into an agreement with the Litherland District Council, under which the Liverpool authorities will construct certain tramways within the area of the Litherland District Council, to provide electric tramway convenience for residents within the area. A draft agreement has been drawn up for obtaining through passenger traffic with the South Lancashire Tramways Co.

Salford.—The Salford Tramways Committee is considering a proposal of the Barton Rural Council with regard to the leasing of a proposed light railway at Clifton. The line is to connect the district of Kersley with that of Swinton and Pendlebury, at Newtown. When it is completed, communication will be established between Manchester and Salford, on the one hand, and the borough of Bolton on the other, by way of Clifton and Farnworth.

Southport.—The Tramways Committee has given orders that one of the cars shall be fitted with Hudson & Bowring's life guards. It is intended to fit up 22 out of the 28 Corporation cars with the new guard. A trial was made with a "dummy" with satisfactory results; the car was run at four to 16 miles an hour, the dummy being picked up in every instance. Hitherto the guard in use has been the Tidswell.

Spain.—The Sarria-Barcelona Railway Co. proposes to adopt electric traction in place of steam on its line.

Sunderland.—At a meeting of the Tramways Committee on 16th inst., the question of the charge for energy, which is obtained from the Electricity Committee at a cost of 2d. per unit, was again discussed at some length. The Tramways Committee considers the charge exorbitant, more particularly in face of the fact that large consumers can obtain electricity used in large quantities at a very much lower price than is the case with the tramways. It contends that the tramways are thus put upon an unfair footing, and that some of the profit made by the electricity producing concern is really filched from the tramways, which are to that extent handicapped. A long list was placed before the Committee showing the prices paid by different towns for their supply, and in almost every case the price was 1½d., or even less. The matter was again adjourned, and the electrical engineer was asked to prepare a report as to the cost of production. At the same meeting it was decided to recommend the Corporation to build offices at a cost approximating on £4,700. Those at present occupied are of a temporary character.

Urmston and Trafford Park.—The Trafford Park Estates Co. have caused plans and estimates to be prepared for a tramway which is to run through the Park from Old Trafford, close to the Ship Canal Docks, to the Urmston railway station, on the Cheshire Lines Railway. The line will make a short cut across fields, after leaving the Park near Mode Wheel, to Urmston. Travellers will be able to save the journey by way of Stretford village. As an alternative scheme, a line has been suggested from Trafford Park along Lostock Road, Davyhulme, and Croft's Bank Road, to the Urmston boundary.

TELEGRAPH AND TELEPHONE NOTES.

Alexandria—Cairo Telephone.—The Cairo correspondent of the *African World* understands that the local telephone company has come to an arrangement with the Telephone Administration whereby, in a short time, the company's subscribers will be able to communicate direct between the two cities by means of their own instruments.

Dutch-German Cable.—A Reuter dispatch from Washington says that after mature consideration the U.S. Navy Department has informed the State Department that it has no objection to the landing of the projected Dutch-German cable at Guam, in the Ladrone Archipelago. Instructions have accordingly been issued by the State Department sanctioning the landing of the cable. It is explained by the *Standard* that the cable referred to is that provided for in the Convention concluded a year ago between Holland and Germany, and for which those two countries agreed to grant a joint subsidy. It is to connect Menado, in the Celebes, with the projected American cable to the Philippines by way of the Pelew Islands, which belong to Germany, and its importance to the two contracting Powers lies in the fact that it will afford communication with their Possessions in the Eastern Seas, independently of cables touching British territory or controlled by British companies.

Telegraph Cable Imports.—The imports of foreign telegraph cables and apparatus into this country during March reached a value of only £5,960 as compared with £9,506 in the preceding month. The total of such imports for the first quarter of the year is returned at £22,996.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Trinidad-Demerara No. 1	Aug. 27, 1901 ..	..
Dominica-Martinique	May 8, 1902 ..	..
St. Lucia-Martinique	May 8, 1902 ..	..
Guadeloupe-Martinique	May 9, 1902 ..	..
Martinique-Puerto Plata	July 10, 1902 ..	..
Guantanamo-Mole St. Nicholas	Aug. 4, 1902 ..	..
Cayenne-Pinheiro	Aug. 13, 1902 ..	..
St. Lucia-St. Vincent	Sept. 19, 1902 ..	..
Reissa-Issa	Oct. 22, 1902 ..	..
Reissa-Yemani	Oct. 22, 1902 ..	..
Paramaribo-Cayenne	Feb. 27, 1903 ..	..
Zanzibar-Mombassa	March 6, 1903 ..	April 15
Jamaica-Colon	March 12, 1903 ..	..
New York-Hait	April 13, 1903 ..	..
Accra-Lagos	April 7, 1903 ..	April 17
St. Jacques-Haiphong	April 17, 1903 ..	..
Landlines.		
Moulmein-Bangkok	April 16, 1903 ..	April 17
Indo-European between Berlin and Warsaw	April 19, 1903 ..	April 20

Telephone Development in France.—Important Proposals.—M. Trouillot, the French Minister of Commerce, has just deposited in the office of the Chamber of Deputies, a project of law, prepared by M. Berard, Under Secretary of State for Posts and Telegraphs, for the purpose of increasing telephonic communications, with a view to placing the plant of certain of the systems (reseaux) in a satisfactory condition. M. Berard, proposes to ask Parliament to sanction the negotiation of a loan of 3,900,000 fr. at 3 per cent., repayable by annual instalments to be reckoned in the Budget, the whole to be repaid in a maximum period of five years. It is stated that on January 1st, 1903, there were in France 3,523 circuits, representing a total length of 164,000 kilometres of wire. During the year 1902, no fewer than 1,317 circuits were erected, having a development of 20,895 kilometres of wire. All these lines, except those used in international work, were established not at the expense of the State, but by means of advances made by the towns, departments, Chambers of Commerce, &c. These advances are repaid from the profits of the working. One of the main obstacles is the increasing difficulty of obtaining long-distance connections. Moved by the complaints arising from this state of things, but being unable to double the number of lines by means of the ordinary credits, M. Berard invited the employés of his Administration to seek a means for obtaining a better output from the existing lines by disembarrassing them of the service conversations which must be exchanged between the telephonists in order to prepare the "putting through" of subscribers. The solution has been found by constituting a third circuit by means of

two existing circuits. Three telephone lines are thus obtained, of which two are used in the ordinary manner, and the third is employed for the exchange of service conversations. The Under Secretary of State estimates that the moment has arrived for the State to bring its direct and material assistance to the establishment of telephonic lines, which are of general utility, and will fill in the gaps of the present system. At present it is estimated that a sum of 6,000,000 fr. is immediately necessary in order to carry out the most urgent work.

Wireless Telegraphy.—The following is the explanation given in the *Times* of 18th inst. for the stoppage of the service of Marconi press messages from America:—"Owing to the breakdown of a subsidiary device employed in connection with one of the telegraph stations established by the Marconi Co. for trans-Altantic wireless telegraphy, the service of telegrams to the *Times* by Marconigraph from America is temporarily interrupted. The company state that the disablement of the apparatus is purely of a mechanical nature, and that the necessary repairs will shortly be completed."

A new expedition to the North Pole is being planned by German explorers. It is part of the scheme for the submarine boat invented by Dr. Anschutz-Kaempfe to penetrate beneath ice-bergs. To aid the expedition, Dr. Scholl, of Munich, has organised a separate expedition to erect a wireless telegraph station and observatory at a point between lat. 78 and 80° north. This station is to communicate with the submarine boat, which will be equipped with wireless telegraphy apparatus. Messrs. Siemens & Halske, of Berlin, operating the Braun wireless telegraph system, are backing Dr. Scholl and preparing special instruments for the wireless telegraph station, which will make meteorological, magnetic, oceanographic and other scientific investigations. The results are to be conveyed by means of wireless telegraphy communications to the civilised world.

It was announced a few days ago that a general agreement has been arrived at between Marconi's Wireless Telegraph Co. and a group of Danish financiers in Copenhagen for the establishment of a wireless system between Iceland and the North of Scotland. The arrangement was stated to also contemplate the establishment of telegraphic communication between Reykjavik, the capital, and the most important places in Iceland. The *Times* correspondent at Copenhagen has since reported that the statement is not quite correct. The agreement which has been made is of a preliminary or provisional kind, and only involves an option for a Danish association to carry out the project.

A Reuter's dispatch from Rome, April 18th, says that the Marquis Luigi di Solari, who is at present in London, has submitted to Signor Marconi, on behalf of the Italian Government, a convention for the establishment on the coast and on the islands off the Italian coast of a system of 12 Marconi radio-telegraph stations, of the average range of 300 kilometres, to be used for commercial and military purposes. Some of the stations are to be complete before the end of the present year, and the others within the first half of 1904. Two of these 12 stations will be those already established at Punta di Vela and Montemario, which will, however, be strengthened. These will be exclusively reserved for military use; others to be used for both military and commercial purposes, will be established at Cape di Leuca, near Gaeta, at Elba and at Asinara. By the present convention, Signor Marconi cedes his apparatus to the Government free of charge, and gives permission for them to be reproduced in military establishments, stipulating, however, for a guarantee that his patents shall not be infringed. The receipts from telegrams sent from stations on the Italian coast will be paid in, in their entirety, to the Italian Treasury; receipts from dispatches sent from ships provided with Marconi apparatus will go to the Marconi Co.; and, finally, the State will receive a fixed tax of one lira per message above the ordinary cost of telegrams. Already many of the great shipping companies, whose vessels touch at Mediterranean ports, have made agreements with the Marconi Co. for the immediate installation of wireless telegraph apparatus on their vessels. Signor Marconi and the Marquis di Solari were to leave London for Rome on 26th inst.

The following very interesting communication from Mr. Mark Barr appeared in the *Times* of April 21st:—"The trial at Poldhu of attuned electrical circuits, which was described by Dr. Fleming in the *Times* of Tuesday last, involved the use of two wave frequencies only. With but two frequencies it is obvious that the wave periods can be made to differ enough to make the resonance effective. The public wish to know what will happen when not two, but 200 independent stations, on ships and on shore, are at work in rivalry, or even on a friendly basis. This constant questioning on the part of the public must not be regarded as carping. The results obtained by Marconi, Lodge, Slaby, Righi, and other brilliant physicists speak for themselves. Unquestionably Mr. Marconi has accomplished marvels of which few had even dreamed. But the public have been drawn into a veritable controversy through no fault of their own. Meagre details have been published and piece-meal announcements have been made at all stages. A *furore* has been set going; and not only the small matter of cable shares, but the whole theory of public faith in publicly-made statements is involved in a way which it is important should now be clearly examined. There is a gamut of utilisable ether wave frequencies outside which practical wireless messages cannot be transmitted. It is a finite gamut, and within it all choices must be made for the future wireless stations on land and at sea. And the public repeats: When there are not two but 200 stations at work, will there be sufficient difference between any two pairs of them to give the selective consonance hoped for? Will the gamut be apportioned to the world in octave lots? Will there be a workable international law against the creation of ether waves of unregistered pitch? What police system, what sort of universal Scotland Yard can even trace the whereabouts of offenders who may elect to send out 28-H.P. ether remors from Ultima Thule? We are not informed of any scheme which gives immunity to a wireless receiving station except that which depends upon attuning. The mirrors shown in earlier patents are found to be ineffective. Dr. André Broca, in last year's *Annuaire*, dealt with this point in a simple and convincing manner. If, then, there can be no screening or focussing of the rays, and if immunity depends upon the absence of certain selected wave periods, what is the probability that no accidental interference will be set up among 100 ships which are all sending messages at once? And still more pertinent is the question regarding intentional interference, the object of which is not message-tapping but obliteration. There is no parallel between such interference and the cutting of telegraph wires. The one is an obliteration of messages in mid-ocean (say) caused by researches on the ether in (say) Spain. The other is the destruction of private property by a trespasser. The pitch or frequency of electrical waves is altered by making changes in the proportion between electrostatic capacity and inductance. This can be done very rapidly. Suppose, then, a rival to N, a given ether telegraphist, produced a radiation of Hertzian waves which many times in a minute would pass and repass through the gamut of frequencies. N could not send clear messages. Nor could N determine the locality of his rival."

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria. — May 1st. The Laa-am-Thaya (Lower Austria) Communal Council wants offers for the establishment of a central power station for the production of energy and lighting by gas or electricity.

Basingstoke. — May 8th. The Corporation invites tenders for a 21 years' lease of the electric lighting order. See "Official Notices" to-day.

Bath.—April 27th. Cables for Corporation electricity supply extensions. See "Official Notices" April 10th.

Brighton.—June 8th. The Council wants tenders for 5,400 KW. generating plant at Southwick power station, and 5,000 KW. motor-generator converting plant, together with switchboards, instruments, &c., at North Road power station. See "Official Notices" April 17th.

Cairo (Egypt).—May 12th. The Egyptian Government is inviting tenders for an installation for the transmission of power for public and private purposes at Ghiza and Jhezira. See this column for April 3rd.

Coventry.—May 6th. Two 8 ft. 6 in. × 30 ft. Lancashire boilers. See "Official Notices" to-day.

Edinburgh.—May 4th. Electricity meters (12 months' supply). See "Official Notices" April 17th.

Faversham.—April 27th. Two 80-B.H.P. oil engines, battery, switchboard, and mains. See "Official Notices" April 3rd.

Germany.—The Municip l Authorities of Werdau-in-S. are at present inviting tenders for the establishment of a central station for the supply of electrical energy to Werdau, Crimmitschau, and districts.

Glasgow.—May 4th. Cables, meters, carbons, &c., for the electrical department. See "Official Notices" April 10th.

Glasgow.—May 5th. Carbons, rubber cables, &c., for the electricity department. See "Official Notices" April 17th.

Govan.—April 27th. Battery, boosters, switchboards. See "Official Notices" April 10th.

Hackney.—April 30th. Ferranti switchboard extensions, &c., piping and valves, and meters for the Council. See "Official Notices" April 3rd.

Hungary.—May 31st. Tenders are invited by the municipal authorities of Veszprem for the lighting of the town either by gas or electricity.

Ipswich.—April 27th. Piping, pumps, &c., for the electricity scheme. See "Official Notices" March 27th.

Islington.—May 27th. Alternating current transformers. See "Official Notices" to-day.

Kettering.—May 1st. Boilers, engines, dynamos, battery, switchboard, lamps, mains, &c., for electric lighting installation. See "Official Notices" April 3rd.

Lancaster.—At the annual Easter Vestry it was decided that St. Thomas Church should be lighted by electricity, and Mr. John Hatch, J.P., Churchwarden, is receiving tenders for the installation.

Leyton.—May 13th. Low-tension cables. See "Official Notices" to-day.

London.—May 4th. Electric wiring at the Bow Road Infirmary for the City of London Union. See "Official Notices" to-day.

Newport (Mon.).—April 27th. Two multipolar motors. See "Official Notices" April 10th.

Rangoon.—July 1st. The Municipal Committee wants tenders for carrying out its electric lighting license, and particulars, forms, &c., can be obtained from the officiating secretary (W. Shircore), Rangoon municipality, at Rs. 75 per set.

Roumania.—April 28th. The Municipal Authorities of Constanza are inviting tenders until the 28th inst. for the lighting of the town either by gas or electricity.

Sheffield.—May 2nd. Piping and high-tension switchboard for the Neepsend new power station. See "Official Notices" April 17th.

Southwark.—April 29th. 50 meters, boards, fuses, &c. See "Official Notices" April 17th.

Stockport.—May 13th. Steel structural work for the Millgate electricity station. See "Official Notices" to-day.

Stretford.—April 30th. The Electricity Committee invites tenders for:—Contract No. 9.—Wiring of works and offices, including electrically-driven fans; contract No. 11.—Equipment of test room.

Sunderland.—May 4th. Electric tramway stores. See "Official Notices" to-day.

Whitby.—April 30th. Mechanical stokers and induced draught fan for the electricity department. See "Official Notices" April 17th.

CLOSED.

Aberdeen.—The Corporation has ordered 4¼ miles of Dialite cable from the St. Helens Cable Co.

Ashton-under-Lyne.—The T.C. has accepted the following tenders:—Messrs. Hadfield, Ltd., for bars, bolts, &c.; Messrs. R. W. Blackwell & Co., for central pole brackets; Messrs W. T. Glover & Co., Ltd., for feeder cables.

Belgium.—Six tenders—three Belgian, two German and one French—were submitted for the electric lighting installation in the Theatre Royal, Liège, the lowest being that of Messrs. Siemens and Halske, of Berlin.

Bexhill.—In response to the Corporation's recent invitation, there were 14 tenders received for the 10-ton overhead travelling crane, the prices ranging from £194 to £450; that of Messrs. Flavell & Churchill, at £210, was accepted. For the water-tube boiler and superheater, 11 tenders were sent in at prices ranging from £929 to £1,300; the lowest, that of Messrs. Babcock and Wilcox, at £929, was accepted. The tenders received for the 300-kw. steam dynamo numbered 166, and the prices varied from £2,131 to £3,338. The contract for this portion of the work was placed with the British Westinghouse Electric and Manufacturing Co., Ltd., for a Belliss & Morcom engine, and a Westinghouse dynamo, at £2,839. Mr. W. T. le Feuvre is the borough electrical engineer.

Brighton.—The T.C. has accepted the tender of the Wheeler Condenser and Engineering Co., for the supply of four funnels, raising the cooling towers at the electricity works by some 30 ft., at £522.

Chester.—Messrs. Chamberlain & Hookham are to supply 100 electricity meters to the Electricity Committee.

Colchester.—Messrs. Berry, Skinner & Co., of Upper Thames Street, E.C., have obtained the contract for a year's supply of house service cut-outs for the Corporation.

Cork.—The Sunbeam Lamp Co., which supplied the lamps for last year's Exhibition, has now obtained the contract for the whole of the lamps required for the International Exhibition of 1903.

Croydon.—The Corporation has accepted the tender of Mr. Arthur Koppell (£616) for a cooling tower, which is to displace the present cooling pond at the generating station. The tender of Messrs. Wm. Cory & Sons, Ltd., for the supply to the generating station of Nixon's Navigation coal at 24s. 6d. per ton delivered has also been accepted.

Dartford.—The U.D.C. has accepted the tender of Messrs. J. Carter & Son for a new boiler, economiser, feed pump and pipe work for the Electricity Works; also that of Messrs. T. Ledward & Co. for an evaporative condenser.

Devonport.—For an installation of the equivalent of 110 8-c.p. lamps and two arc lamps at Messrs. Prynn Bros., Tavistock Street, the tender of Messrs. Lord & Shand has been accepted.

Gravesend.—The T.C. has accepted the tender of Messrs. Dawson & Co. for the supply of cylinder, crank chamber and dynamo oils to the Electricity Works.

Guildford.—The Surrey County Hospital Committee has accepted the tender of Messrs. Carling, Gill & Carling, Ltd., electrical engineers, of Guilford, for the installation of the electric light at the Hospital at £310, and at the Nurses' Home at £45.

Heckmondwike.—The following tenders have been accepted by the U.D.C.:—Dick, Kerr & Co., for a dynamo coupled to an engine of the triple-expansion type, built by Jas. Howden and Co.; W. T. Henley's Telegraph Works, Ltd., for feeder cable.

Lowestoft.—The T.C. has accepted the tender of the British Westinghouse Co., for the supply of an additional motor balancing plant at the electricity works at £872.

Manchester.—Electric driving is to be adopted at All Saint's Parish Church, for the church organ. The work has been entrusted to Messrs. J. Lomax Kendal & Co., of Manchester, who will instal an Aston-Lundell motor, complete with Veritys' organ regulating devices.

Perth.—The offers of the British Electrical Plant Co., amounting to £1,814, for the engine and dynamos, and of Babcock and Wilcox, for the boiler amounting to £960, have been accepted by the E.L. Committee.

Plymouth.—For an installation of the equivalent of 700 8-c.p. lamps for the Head Post Office, the tender of Messrs. Lord and Shand, Ltd., has been accepted. The same firm is also to carry out an installation of the equivalent of 450 8-c.p. lamps at the Wesleyan Church, Mutley.

Rhodesian Railways.—The Electric Railway and Tramway Carriage Works, Ltd., of Preston, have just been awarded an important contract for railway rolling stock for the Rhodesian Railway of South Africa. The order consists of special carriages for the use of officers of the line, namely:—Agent's carriage, medical officers' carriages and district officers' carriages. The plans for each of the above provide for comfortable accommodation by day and night, and they are, therefore, to be fitted with kitchen, dining, sleeping and office rooms, lavatories, &c. The carriages will have steel underframes, the most modern type of running gear, vacuum brakes, &c., and all woodwork will be chiefly of teak finished in its natural grain. Delivery is an important item of the contract, and it is expected the carriages will be built, boxed, and packed ready for delivery by August 15th.

Sandringham.—Messrs. Whittaker Bros., of Dudley, have received an order from his Majesty the King for the installation of the electric light in the Church Technical Schools, and the Park House, on the Sandringham estate.

Stoke-on-Trent.—Two three-grate front feed regenerative destructors to work in connection with electric light installation are to be supplied by Messrs Meldrum who are also supplying a two-grate destructor with supplementary coal fired boiler, economiser, &c., to work in connection with an electric light installation at Holyhead; and a two-grate Simplex to work in connection with the Kettering electric light installation.

Walsall.—The T.C. has accepted the tender of Messrs. Thos. Parker, Ltd., for supplying the magnets for two transformers for £925; and of Mr. Thos. Tildesley for erecting an economiser house at the Wolverhampton generating station for £174.

War Office.—The Premier Electric Lamp Co. have secured a contract from the War Office for a number of Premier incandescent lamps.

Warrington.—The T.C. has accepted the tender of the Mersey Electric Lighting Co., for the electrical wiring of the No. 1 ward at the Aikin Street Hospital; also that of Babcock & Wilcox, boilers and pipework at the electricity works at £3,282; Siemens Bros. & Co., Ltd., engines and dynamos at £11,434; Messrs. Kelvin and White, for switchboard at £446.

FORTHCOMING EVENTS.

Friday, April 24th.—At 9 p.m. Royal Institution. Discourse by the Hon. R. J. Strutt, M.A., on "Some Recent Investigations on Electrical Conduction."

At 8 p.m. Junior Institution of Engineers. Westminster Palace Hotel. Paper on "The Effect of Design on Methods of Construction from a Contractor's Point of View," by R. W. Newman, M.I Mech.E. (Vice-Chairman).

I.E.E. (Dublin). "Note on Electric Generating Stations of the Future," by A. W. Whieldon.

Monday, April 27th.—At 8 p.m. Society of Arts. "Mechanical Road Carriages," by W. Worby Beaumont. Cantor Lecture I.

Wednesday, April 29th.—At 7.30 p.m. I.E.E. (Birmingham Section). Paper on "Notes on Motor Starting Switches," by A. H. Bate.

At 6 p.m. Conference at Anderton's Hotel on Free Wiring. [See Note on p. 706.]

Thursday, April 30th.—At 5 p.m. Royal Institution. Prof. Dewar on "Hydrogen: Gaseous, Liquid and Solid." (Lecture II.)

I.E.E. (London). "Divided Multiple Switchboards: An Efficient Telephone System for the World's Capitals," by W. Aitken.

Friday, May 1st.—At 9 p.m. Royal Institution. Discourse by Prof. W. J. Pope, F.R.S., on "Recent Advances in Stereo-Chemistry." [Annual meeting at 5 p.m.]

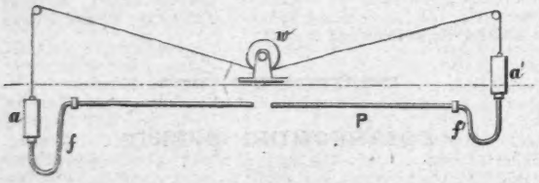
NOTES.

Solid Electrolyte Cells.—In *Electro-chemical Industry* of March, 1903, Mr. A. L. Marsh describes the results of some experiments with cells having solid dry electrolytes. He first gives the history of such cells. This seriously began with that of Shelford Bidwell in 1885, which consisted of a silver-copper element in which the electrolyte was sulphur containing 15 per cent. of copper sulphide (Cu S). Although it was dry, it gave an E.M.F. of 0·07 volt (silver being +), and had an internal resistance of 6,537 ohms. Bidwell later considerably improved on these results. Mr. Marsh tried several improved combinations, among which were the following:—(1) Copper, mixture of copper phosphide and red phosphorus, zinc (amalgam); (2) Copper, mixture as in (1), sodium; (3) Copper, arsenic (metallic), sodium; (4) arsenic, sodium. Every precaution was observed to render the couples anhydrous, and (2), (3) and (4) were submerged in a light oil. (1) gave 0·8 volt; (2) gave 1·5 volts, and the resistance was less than 100 ohms per square inch of contact surface; (3) gave at the start 0·05 volt, and after being connected through a 1,000-ohm resistance for 10 days it steadily increased to 0·3 volt; (4) gave 1·2 volts. How far this action is electrolytic it is not easy to guess; the idea of dissociation as usually conceived does not seem to be applicable, and the last-named couple seems to have got on quite comfortably without anything corresponding to an electrolyte. Whether the contact pressure is produced by some species of molecular diffusion or whether it is a modification of thermo-electricity can only be decided by carefully comparing the amount of corrosion (if any) with the current passed.

Obituary.—We learn with regret of the death at Clevedon, Somerset, at the early age of 37 years, of Mr. E. Tremlett Carter, who has for several years past been editor-in-chief of the *Electrician*. The deceased gentleman was a victim of consumption, which disease he has recently been fighting by means of the open-air treatment. Mr. Carter's name may be best known to readers of the Electrical Review through the articles which he wrote for this journal about 1892 to 1894 on "Water Power," "Arc Lighting," and various other subjects. An article in our Journal for July 8th, 1892, shows that 11 years ago he was writing on the subject of tramcar brakes with reference to the work required of a brake when descending very steep gradients.

Electrical Equipoise for Air Ships.—The great desideratum in successful aerial navigation by means of air ships combining an aërostat with a system of aëro-planes, is to provide an automatic equipoise at any desired angle or plane. Birds and insects possess an instinctive sense of equilibrium in flight, which is anticipatory in action. The only method by which a mechanical equivalent can be applied to an air ship, is by using an electrical current, and this has been successfully done by Mr. Fred. Walker, of Oxford, and Dr. F. A. Barton, the well-known aeronaut. In fig. 1 a longitudinal pipe P extends along the bottom of the car, and communicates with two vessels, a a', by means of flexible pipes f f'. The lower vessel a contains a volume of mercury, and a' is empty, since it is raised above the normal level by the winch w, a being correspondingly lowered, thus inclining the air ship in either direction. Fig. 2 shows the electrical circuits and general arrangement. The equilibrium device, E, has been already described in the Electrical Review of June 3rd, 1902, and consists of a box

Fig. 1.



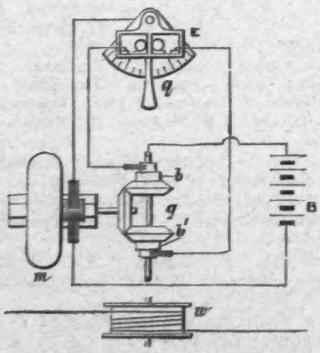


Fig. 2.

having a central division, containing two contact rollers, which normally open the circuit when resting against the division. When the box is inclined to either side, contact is made either to the right or left from a Hart accumulator set (motor-car new type), B, through a motor, m, and one of the electro-magnetic clutches b or b', thus rotating the winch w in either direction without reversing the motor m. If the plane of flight be other than horizontal, it may be set by moving E by the handle to any point of the quadrant q. The accumulators are also utilised for ignition purposes on the petrol engines used for propulsion. The clutch consists of an electro-magnet with semi-circular poles, having a coned face fitting a coned sleeve on the wheel. An insulated contact ring conveys the current to the coils of the electro-magnet, and when magnetised, the poles grip the sleeve against the tension of a spiral spring; as the clutch slides on a feather, and the wheel is loose on the shaft, the latter is rotated whilst gripped. The apparatus is said to be extremely sensitive, and to approximate as nearly to the nervous and muscular actions in the flight of birds and insects as is possible by artificial means. It is found that with a 2¼ in. pipe, a weight of 200 lbs. can be transferred over 180 ft. in 6 seconds; there is little power required, and the motor only runs when required. The device will be used on the new air ship now building for the War Office.

The New Tool Steels.—We need not concern ourselves with the question of the priority of discovery of the new tool steels. It is certain that Mushet did much pioneer work in self-hardening steel, and that he obtained his results by adding tungsten and manganese to the steel, which enabled it to maintain its cutting edge at a higher temperature than was possible with ordinary steel, and therefore higher cutting speeds were made possible. But the full advantage of Mushet steel could not be secured with weak and slow-geared machines, and it has only been lately that further advances have been made in the same direction. The Taylor-White process came out in America, and all British and Continental steel makers have their own special steels of the variety that will cut when red-hot. These new steels only seem to be suitable for roughing cuts, but they may be used up to 150 ft. per minute, though probably half that speed is a more commercially possible or practicable velocity. These new steels generally appear to be compounded with at least 1 per cent. of metals of the chromium group, and chromium itself should be half of the addition, the percentage of carbon apparently being unimportant, according to a report by a committee of the Franklin Institute who state that from ·85 to 2·00 of carbon seemed to afford equal efficiency. For a temperature of 1,450° F. a chart of behaviour shows a speed of 30 which rises between 1,525 and 1,575°, and has fallen very low at 1,675°. This is the breakdown point above which at 1,900° the velocity of cutting is 120 and still rising. The breaking down or critical point is very curious. In practice it seems that it will keep down speeds at such a point as will not produce more than a given temperature, but that if the critical point can be passed the temperature may be very high indeed. The point we wish particularly to make is that machine tool speeds and cuts are no longer limited to the slow creeping cuts of a few years ago. Rough turning and boring can be done on heavy lathes and mills, which must be powerfully geared and run fast. The present prices for work will not permit of the old crawling speeds being employed. If manufacturers will note the speeds being run in feet per minute and compare them with speeds that ought to be run, they will begin to appreciate the reasons for adverse balance-sheets. The ordinary workman brought up on low speeds is often the bar to progress. He is positively afraid to see a lathe run at 60 ft. per minute peripheral speed. Often enough it is not strong enough to do so, but given the strength the man would still be afraid. An ignorant labourer brought in to attend such a machine, and commencing in absolute ignorance of machine speeds, will not be afraid of any machine he may be told is correct, and he will run a machine at this speed, and will soon secure double, treble, or even quadruple the output of the experienced man, who cannot, perhaps, grasp the significance of the new order of things, and is afraid of modern speeds simply because he is not accustomed to them. Some few years ago it was American practice to forge fine and do little machine work. Now they are coming round to the old style of rougher forgings, and are using the new steels to turn off the surplus material. Changes of tool steel will affect the whole of shop practice, and we would specially caution manufacturers not to purchase new machinery that will not run at the full speed fit for the new steels, or they may soon find themselves with a lot of new and inefficient tools that cannot earn a dividend, and are fit only for the scrap heap. With the new steels a little British weight—call it clumsiness, if you will—is an advantage that may, in cases, keep up the value of a tool that would otherwise have proved useless. Heavy spindles, face plates directly geared, good long bearings, and the tool pressure carried down directly through parts free from overhang to a heavy bed are essential to high output and to getting full duty from the steel.

Free Wiring.—A conference between Supply Companies and Municipalities and electrical contractors will take place on Wednesday, April 29th, at 6 p.m., at Anderton's Hotel, Fleet Street, E.C. The subject for discussion is "Systems of Rental and Free Wiring." Representatives from the following Supply Undertakings have already promised to attend:—Westminster Co.; Crystal Palace Co.; Charing Cross and Strand Co.; Woking Electric Supply Co; Metropolitan Electric Supply Co.; Shoreditch Borough Council; Borough of Fulham; Borough of Stepney; Borough of Ealing; and Barking U.D. Council.

Personal.—The Newport (Mon.) T.C. has appointed Mr. L. de R. du Verge as deputy borough electrical engineer and tramways manager with an increase of salary.

The council of University College, Liverpool, has elected Mr. E. W. Marchant, D.Sc., to the professorship of electrotechnics, for the foundation of which £10,000 has been given by Mr. David Jardine.

Rand Notions of English Electrical Machinery.—The criticism of the Johannesburg Chamber of Trade of Messrs. Mordey & Dawbarn's electric scheme for Johannesburg displays, incidentally, some curious errors regarding the capabilities of English-made appliances which are worth drawing attention to for the lesson they inculcate on the great need our manufacturers have of ensuring the fullest publicity regarding the qualifications of their machinery. The Chamber averred that "there is normally a loss of energy of at least 6 per cent. in a 5-KW. transformer." To this the consulting engineers point out that this amount of loss is common with many transformers of foreign make; but it is not so with those of English manufacture, when built to a proper specification, with which the loss is only 1 or 1¼ per cent. As a matter of fact, with the transformers which the Chamber of Trade were familiar with and had in mind, there would undoubtedly have resulted a huge aggregate loss of energy on the working; but this type was not at all the same as that which the consulting engineers had in view. Obviously, the better performances of English appliances are unknown to a considerable number of business people in Johannesburg, despite the fact that many members of the Chamber of Trade represent several important English electrical engineers, thus giving occasion to this false impression and conclusion, and the moral of the opening lines of this paragraph as to the necessity for greater publicity is, in consequence, seen to be enforced.—*British and South African Export Gazette.*

Manchester Electricity Department Finances.—The estimates of the Electricity Committee for the year ending March 31st, 1904, have been issued. The estimated expenditure is £242,450, including £105,457 for interest and sinking fund, and the estimated income amounts to £233,000, leaving a balance of the estimated loss of £9,450 to be taken out of the reserve fund. The estimated expenditure for the year just ended was £175,459. The approximate expenditure, however, comes to £188,828. The income for the same period was estimated at £166,447, but the actual income was £189,266. It may be noted that the Committee expect to receive during the coming year £150,800 for current, meter and motor rentals, and £81,250 for current supplied to the tramways department. Last year the approximate income from these two sources was £140,808 and £47,466 respectively. The expenditure out of the capital account during the forthcoming year is estimated at £350,000, which includes £200,000 for the Stuart Street station, £66,000 for distributing stations, £42,000 for mains, £20,000 for Dickenson Street station, £16,000 for Bloom Street station, £5,000 for motor and minor amounts for meters and other purposes.

Appointments Vacant.—An electrical engineer at £150 is wanted for Bray; an assistant mains superintendent is required for Sunderland. See our "Official Notices" to-day.

Institution of Electrical Engineers.—It is announced that there will be extra meetings of the Institution on April 30th and May 7th. It is expected that Mr. Aitken's paper on Telephone Exchanges will be read and discussed at the meeting on April 30th.

The following is a list of Council nominations for election of Council and hon. officers for 1902-04, which were announced at last night's meeting:—

President.—Mr. Robert Kaye Gray.

Vice-Presidents.—Mr. John Gavey, Prof. Sir O. Lodge, D.Sc., F.R.S., *Dr. J. A. Fleming, F.R.S., *Mr. J. E. Kingsbury.

Members of Council.—Sir J. Wolfe Barry, K.C.B., F.R.S., *Mr. T. O. Callender, Mr. S. Dobson, Mr. B. Drake, *Mr. S. Z. de Ferranti, *Mr. F. Gill, *Mr. F. E. Gripper, Mr. H. E. Harrison, B.Sc., Lieut.-Col. H. C. L. Holden, R.A., *Mr. G. Marconi, *Mr. W. M. Mordey, The Hon. C. A. Parsons, F.R.S., Mr. W. H. Patchell, Mr. J. H. Rider, Mr. A. A. Campbell Swinton.

Associate Members of Council.—Mr. W. Duddell, Mr. Sydney Morse, *Mr. A. J. Walter.

Honorary Auditors.—Mr. F. C. Danvers, Mr. Sidney Sharp.

Honorary Treasurer.—Mr. Robert Hammond.

Honorary Solicitors.—Messrs. Wilson, Bristows & Carpmael.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the Council in accordance with Article 45 of the Articles of Association. All the honorary officers being eligible, were nominated for re-election.

Large Electric Locomotives.—Messrs. D. Bruce Peebles & Co. inform us that their licensors, Messrs. Ganz & Co., have received an extension order for the Valtellina line for three locomotives, each capable of developing 1,700 B.H.P. when running at a speed of 40 miles an hour. Each locomotive will be fitted with four motors, which will be worked singly at 40 miles an hour for passenger service, and in cascade at 20 miles an hour for goods service. It is interesting to note that these are not only the largest electric locomotives ever ordered, but that they are of higher power and capable of exerting a larger draw bar pull than any steam locomotive ever hitherto constructed on any line in the world. This fact is especially significant when we remember that these locomotives are to be supplied with three-phase current at 3,000 volts from overhead conductors, and will run on an electric system 66 miles in length, fed from one generating station.

Wireless Telegraphy in the French Fleet.—Wireless telegraphy, which rendered such important service during the Czar's journey in France, has just given proof of its capacity in the course of the political journey which M. Loubet, President of the French Republic, is at present taking in Algiers. In proceeding to Algiers, the *Jeanne d'Arc*, which carried President Loubet, was able to keep in communication with Toulon up to 210 miles, say 390 kilometres. Several dispatches were exchanged under official control quite satisfactorily. The receivers which were used were those of Capt. Ferrié, of the *Génie Français*, already described in the columns of the Elec. Rev.

THE CENTRAL STATION ENGINEER.

On Saturday afternoon, at King's Road Station, Camden Town, after the whole of the staff had been through the ordeal of being photographed, Mr. L. Pettit, the chief assistant, who is leaving England shortly for Canada, was presented with a case of pipes and a writing case, by Mr. P. N. Hooper, the resident engineer, on behalf of the staff of the station. Mr. Hooper, in making the presentation, said that Mr. Pettit had been at King's Road station upwards of four years.

Mr. C. W. Salt has been appointed junior assistant electrical engineer to the Croydon Corporation.

The staff of employés at the Croydon Corporation Electricity Works showed untiring energy in dealing with the outbreak of fire at the generating station some months ago, which threw the town into darkness for two nights, and the insurance company have granted a sum of £75 for distribution amongst them. The Corporation have added another £25, and the gift has been greatly appreciated by the recipients.

Mr. E. G. Jones, who has relinquished the position of electrical engineer to the Town Council of East London, Cape Colony, in order to proceed to Johannesburg, was recently, at a meeting of the Council, awarded a bonus of £250 for valuable services in connection with the electric lighting and tramway schemes of the town.

NEW COMPANIES REGISTERED.

Fenner, James & Co., Ltd. (76,952).—This company was registered on April 4th, with a capital of £3,000 in £1 shares (1,500 preference), to acquire the business carried on by V. A. Connor and E. Shouls as "Fenner, James & Co.," to acquire and turn to account any patents, inventions and the like relating to the production, treatment, storage, distribution and use of electricity and any apparatus therefor, and to carry on the business of electricians, engineers, suppliers of electricity for light, heat, motive power and otherwise, &c. The first subscribers (each with one preference share) are:—H. H. Lavington, 17—8, Ironmonger Lane, E.C., solicitor; J. D. Jordan, 17—8, Ironmonger Lane, E.C., solicitor: J. W. Dormann, 84, Sherbrooke Road, Fulham, S.W., clerk: W. K. L. Dickson, 64, Strand, W.C., electrical engineer; Capt. W. A. Grant, Castle Malwood, Lyndhurst, Hants.; V. A. Connor, 49, Carrfield Gardens, S. Hampstead, N.W., electrical engineer; and S. I. Field, 7, Shaftesbury Avenue, W.C., incorporated accountant. No initial public issue. The number of directors is not to be less than three nor more than five; the first are Capt. W. A. Grant, W. Kennedy-Laurie Dickson and V. A. Connor; qualification, £50; remuneration as fixed by the company. Registered office, 17, Shaftesbury Avenue, W.C.

Worthington Pump Co., Ltd. (76,986).—This company was registered on April 7th, with a capital of £500,000 in £10 shares, to acquire and take over all or any part of the capital, stock or shares of James Simpson and Co., Ltd., the assets and liabilities of the Worthington Pumping Engine Co., of New Jersey, U.S.A., and all or any the agencies for Great Britain and Europe of the George Blake Manufacturing Co., of New Jersey, U.S.A., and all or any of the assets and businesses of or in connection with such agencies, and to carry on the business of ironfounders, engineers, manufacturers of pumps, agricultural implements and other machinery, tool makers, brass founders, metal workers, boiler makers, millwrights, machinists, iron and steel converters, smiths, woodworkers, builders, metallurgists, electrical and water-supply engineers, gas makers, &c. The first subscribers are:—C. L. Simpson, 101, Grosvenor Road, S.W., engineer, 10 shares: E. W. Husted, 153, Queen Victoria Street, E.C., merchant, 10 shares; T. B. Simpson, 101, Grosvenor Road, S.W., engineer, 10 shares; E. P. Simpson, 58, Kensington Gardens Square, S.W., barrister, 10 shares; J. A. Reavell, 179, Queen Victoria Street, E.C., engineer, 10 shares; F. M. Crisp, 5, Lansdowne Road, W., secretary, one share; and J. Proffitt, 32, Great George Street, S.W., solicitor, one share. No initial public issue. The number of directors is not to be less than nine nor more than 15. The first are C. L. Simpson, E. W. Husted, T. B. Simpson, E. P. Simpson, J. A. Reavell, E. A. Freeman, M. J. Burn, J. E. D. Ryder and A. B. Simpson; qualification, £100. Any director who is an officer or employé of the company, or of any company the ordinary shares of which are controlled by the company shall receive no remuneration; remuneration of other directors, £100 each per annum.

Bath and District Light Railway Co., Ltd. (76,989).—This company was registered on April 8th, with a capital of £225,000 in £1 shares, as a re-incorporation under the Companies' Acts, 1862 to 1900, of the Bath and District Light Railway Co., constituted by the Bath and District Light Railway Order, 1901, confirmed by the Board of Trade on November 2nd, 1901. The said order authorised the construction, maintenance and use of certain light railways, electrical works and apparatus, &c., and provided that the number of directors should be five and their qualification £250 each, the company having power to decrease the number of directors to not less than three, nor to increase same to not exceeding seven. The first directors were Sir J. Sivewright, L. Hirsch, and three others to be nominated by them. At the date of conversion, 11,370 shares had been taken up, and 5s. had been paid up on each. The principal members were:—S. V. Caillard, Kt., 92, Cannon Street, with 10,500 shares; W. J. Fuddon, 17, Gracechurch Street, E.C., with 250 shares; E. Helsch, 18, St. Helens Place, E.C., chartered accountant, with 250 shares; and E. H. R. Trenow, 18, St. Helens Place, E.C., chartered accountant with 250 shares. Registered office, 18, St. Helens Place, E.C.

Consolidated Electrical Co., Ltd. (77,054).—This company was registered on April 16th, with a capital of £125,000 in £1 shares, to adopt an agreement with the Consolidated Telephone Construction and Manufacturing Co., Ltd., and G. S. Howell, the liquidator thereof, and to carry on the business of electrical engineers, electricians, suppliers of electricity for light, heat, motive power or otherwise, manufacturers of and dealers in apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity, proprietors of tramways, railways, omnibuses and vehicles, manufacturers of and dealers in rolling stock, engines, trolleys and machinery, iron, brass and steel founders, mechanical engineers, wire drawers, tube makers, &c. The first subscribers (each with one share) are:—C. Woolley, 19, Haycroft Road, Brixton Hill, S.W., secretary; H. F. Jackson, Northampton Grove, Canonbury, N., electrical engineer; G. Kerr, Woodside, Norwood, S.E., merchant; F. Kerr, 31, Harrington Gardens, S.W., director; H. Allen, 88—90, Chancery Lane, W.C., managing director; T. W. Taunton, Freelands, Woolands Road, Ilford, secretary; and M. Parker, 120, Cannon Street, E.C., director. Minimum cash subscription 100 shares. The number of directors is not to be less than three nor more than five. The first are H. Allen (chairman), H. F. Jackson, and C. Woolley. Qualification of first directors and other to be appointed by them prior to meeting in 1904, one share; qualification of other directors, £2,000; remuneration, £300 each per annum (£400 for the chairman), and 5 per cent. of the distributed profits, divisible. Registered office, Northampton Works, Northampton Grove, Canonbury, N.

Rapid Magnetting Machine Co., Ltd. (77,015).—This company was registered on April 9th with a capital of £3,000 in £1 shares, to acquire from S. Benton and H. H. Thompson (trading as the "Rapid Magnetting Machine Co."), the benefit of certain inventions relating to the separation of iron, steel and other magnetic metals from any non-magnetic metals or materials, and to carry on the business of magnetting or separating machine manufacturers and merchants, electrical and mechanical engineers, metal workers, founders, metallurgists, dealers in foundry requisites, &c. The first subscribers (each with one share) are:—E. E. Thompson, 206, Mary Vale Road, Bournville, jeweller; H. Billson, Alton Place, Wylde Green, Birmingham, coal merchant; Mrs. A. Thompson, Rokeby House, Wylde Green, Birmingham; A. D. Keeling, 12, St. Paul's Square, Birmingham, metal manufacturer; S. Benton, Grasmere, Gravelly Hill, metal merchant; H. H. Thompson, 182, Cambridge Street, Birmingham, metal merchant; H. W. Thompson, 182, Cambridge Street, Birmingham, clerk; and A. J. H. Shay, 34, Dunham Road, Sparkhill, articled clerk. No initial public issue. The number of directors is not to be less than three nor more than five; the first are S. Benton, H. H. Thompson and A. D. Keeling; qualification, £50; remuneration as fixed by the company.

Milford-on-Sea Electric Supply Co., Ltd. (77,043).—This company was registered on April 15th, with a capital of £8,000 in £1 shares, to adopt agreements (1) with F. Christy, L. F. Christy and W. Middleton (trading as Christy Bros. & Middleton), (2) with V. Nicholson, L. Nicholson and W. R. Beesley (trading as Nicholson Bros.), and (3) with W. A. Shultz, and to carry on the business of electricians, mechanical engineers, suppliers of electricity for light, heat, motive power and otherwise, &c. The first subscribers are:—E. Neal, Keyhaven, Hants, retired farmer, 250 shares; F. Christy, Chelmsford, Essex, electrical engineer, 250 shares; V. D. Harris, Woodrouffe, Milford-on-Sea, M.D., 250 shares; W. A. Shultz, Uplands, Milford-on-Sea, Hants, 250 shares; F. P. Matthews, 9—27, Hearn Street, Finsbury, E.C., merchant, 250 shares; A. H. S. Emerson, 50, Cannon Street, E.C., chartered accountant, 1 share; and C. Comins, Pembroke House, Bromley, Kent, F.C.A., 1 share. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are F. Christy, M.I.E.E., V. D. Harris, M.D., F. P. Matthews, E. Neal and W. A. Shultz, F.C.A.: qualification, 250 shares; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Stephen Smith & Co., Ltd. (Marine and Electrical Engineers, London) (53,336).—£600 debentures, created and dated April 1st, 1903, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

Renewable Electric Lamp Co., Ltd. (63,144).—Issue, on April 2nd, of £1,200 debentures, part of a series created August 12th, 1902, to secure £5,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. To amount previously issued of same series: £3,800.

United Electric Light and Power Supply Co., Ltd. (Manchester) (73,024).—Issue, on March 25th, of £925 debentures, part of a series created March 17th, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital and all buildings, machinery, and other property, at Guimarães, Portugal. No trustees. No previous issue of same series.

Royce, Ltd. (Electricians, Manchester) (63,871).—A trust deed, dated March 25th, 1903, to secure £25,000 debentures, has been registered. Property charged:—The company's undertaking and property, present and future, including uncalled capital, freehold property in Stretford, leasehold premises in Cooke Street, Manchester, and at Shorland, and patent No. 2,895 of 1899. Trustees:—Law Guarantee and Trust Society, Ltd., 49, Chancery Lane, W.C. Debentures not yet issued.

Aberystwith and Chiswick Electricity Corporation, Ltd. (38,854).—Issue, on April 15th, of £2,500 debentures, part of a series created by resolutions of November 2nd, 1900, and March 8th, 1901, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Total amount previously issued of same series: £25,000.

W. T. Henley's Telegraph Works Co., Ltd. (13,795).—This company's annual return was filed on March 19th, when 35,000 preference and 35,000 ordinary shares had been taken up out of a nominal capital of £400,000, divided into 40,000 preference and 40,000 ordinary shares of £5 each. £5 per share has been called up on 35,000 preference and 29,000 ordinary shares, resulting in the receipt of £320,000. 6,000 ordinary shares are considered as fully paid. Mortgages and charges: £47,000 (£50,000, less £3,000 transferred to trustees).

National Telephone Co., Ltd. (15,066).—This company's annual return was filed on March 27th. The capital is £6,000,000, divided into 15,000 first preference and 15,000 second preference shares of £10 each, 250,000 third preference and 100,000 ordinary shares of £5 each, £1,983,333 6s. 8d. preferred stock and £1,966,666 8s. 4d. deferred stock. All the first, second and third preference shares and preferred and deferred stock have been taken up. £3,174,760 has been received in respect of 12,220 first preference, 15,000 second preference and 221,716 third preference shares, and £1,264,660 preferred and £589,830 deferred stock. £2,625,240 is considered paid on 2,780 first preference and 28,284 third preference shares, and £718,673 6s. 8d. preferred and £1,437,346 13s. 4d. deferred stock. Mortgages and charges: £2,616,920 being £2,000,000 3½ per cent. debenture stock and £616,920 4 per cent. debenture stock.

Charing Cross and Strand Electricity Supply Corporation, Ltd. (79,123).—This company's annual return was filed on March 18th. The capital is £1,400,000 in 80,000 preference, 80,000 ordinary, 40,000 City Undertaking preference and 80,000 City Undertaking ordinary shares, all of £5 each. 70,000 preference, 70,000 ordinary, 40,000 City Undertaking preference, and 40,000 City Undertaking ordinary shares have been taken up. £5 per share has been called up on the preference, ordinary and City undertaking preference shares, and £900,000 has been received. £200,000 is considered as paid on 40,000 City Undertaking ordinary shares. Mortgages and charges: £709,000.

ELECTRICITY SUPPLY ACCOUNTS.

Charing Cross and Strand Electricity Supply Corporation,

We give this week an analysis of the accounts of the West End and City undertakings of the Charing Cross Electricity Co. The Corporation is empowered to supply electrical energy within the following approximate limits:—On the north bank of the Thames from the Tower and Liverpool Street station in the east, to the junction of Wardour Street and Oxford Street, and the Horse Guards in the west, also taking in the Green Park and a portion of St. James's Park. It is also able to supply in bulk to the boroughs of Stepney Bethnal Green, Poplar and West Ham.

The West End business has shown a satisfactory increase—lamps connected having increased by 23 per cent., and units sold by 26 per cent. over the previous year. A portion of the increased output is due to the bulk supply to the City undertaking in the early part of the year. Some 40 miles of mains have been added to the West End system, making a total of 204 miles, and trunk mains connecting the main generating stations at Lambeth and Bow to the distributing stations are in regular work, facilitating the meeting of sudden demands at any part of the area.

The total costs per unit are fractionally greater than in the preceding year, but still run the St. James's Co. (see last week's issue) very close, the latter company having the lowest costs among the metropolitan companies for 1902.

The average price obtained per unit was less, and the surplus profit has not greatly increased over the previous year.

Of the 8,249,950 units sold, 6,385,837 were taken by private consumers, 282,101 by public lamps, and 1,582,012 units supplied in bulk to the City undertaking.

The prices charged are, for lighting, 6d. to 4d. per unit, and power, 4d. to 2d.

The City undertaking gives promise of rapid growth. During the year 99,000 lamps were connected, and proposals were in hand for further additions of 110,000 lamps, electrical motive power also being in considerable demand. During the year the first section of the Bow generating station has been finished, and is in regular work. Some 85 miles of mains have been laid, making a total of 186 laid in the area.

Of the 1,987,640 units sold, private consumers took 1,879,609, and 108,031 were sold per contract.

The prices charged are 5d. and 4d. per unit for lighting, and 3d. to 2d. per unit for power.

Mr. W. H. Patchell is the engineer-in-chief.

West-End Undertaking—

GENERAL STATEMENT.

For the year ending December 31st—	1902.	1901.
Total capital	£764,804	£664,866
Number of units sold	8,249,950	6,553,792
Equivalent number of 8-c.p. lamps	280,605	246,241
Number of public lamps	113	113
Maximum load in kilowatts	3,941	4,023
Revenue Account:—		
Gross revenue	£119,019	£102,710
„ expenditure	£67,884	£52,251
„ profit	£51,135	£50,459
Average price per unit	3·33d.	3·64d.

REVENUE ACCOUNT for year ending December 31st, 1902.

	Per unit.	Gross.
Sale of energy	3·33d.	£114,358
Meter rents, &c.	·09d.	3,332
Fees, house rents and sundries	·04d.	1,329
Total revenue	3·46d.	£119,019

WORKING EXPENSES.

	Per unit.	Gross.
Coal	·78d.	£26,767
Oil, waste, water and engine room stores ...	·05d.	1,719
Salaries and wages incurred in generating and distribution, &c.	·28d.	9,513
Repairs and maintenance of buildings, generating and distributing plant, mains and consumers' apparatus, public lighting, &c. ...	·43d.	15,222
Works and distribution costs	1·54d.	£53,221
Rents, rates and taxes	·20d.	£6,584
Management expenses, salaries of engineer, secretary, clerical staff, directors' fees, &c. ...	·18d.	6,203
General establishment charges, stationary, printing, law, and compensation	·05d.	1,876
Total cost	1·97d.	£67,884

PROFIT STATEMENT.

Interest on debentures	£10,614
Interest on temporary loans	2,205
Dividends on preference and ordinary shares ...	45,232
To depreciation	10,000
Balance from previous year	−10,651
Interest on loans accumulated during year ...	−21,082
Balance carried forward	14,817
Gross profit	£51,135

City Undertaking—

GENERAL STATEMENT.

For year ending December 31st—	1902.	1901.
Total capital expended	£591,101	£234,257
Number of units sold	1,987,640	589,957
Equivalent number of 8-c.p. lamps	150,729	51,836
Number of public lamps	—	—
Maximum load in kilowatts	3,335	991
Revenue Account :—		
Gross revenue	£28,537	9,844
„ expenditure	£23,863	10,600
„ profit	£4,674	−756
Average revenue per unit	3·35d.	3·91d.

REVENUE ACCOUNT for year ending December 31st, 1902.

	Per unit.	Gross.
By sale of energy	3·35d.	£27,774
Meter rentals, &c.	·09d.	747
Sundry fees, &c.	·00d.	16
Gross revenue ...	3·44d.	£28,537

WORKING EXPENSES.

	Per unit.	Gross.
Purchase of energy in bulk from West-end undertaking	·99d.	£8,163
Coal	·35d.	2,899
Oil, waste, water and engine-room stores ...	·02d.	181
Wages incurred in generation and distribution	·34d.	2,788
Repairs and maintenance of generating plant, mains, and consumers' plant	·30d.	2,470
Works and distribution costs ...	2·00d.	£16,501
Rent, rates and taxes	·21d.	1,742
Management expenses, including salaries of engineer, secretary, clerical staff, accountants, &c.	·52d.	4,309
General establishment charges, printing, stationery, law, municipal inspectors' salary, &c.	·15d.	1,311
Total costs	2·88d.	£23,863

PROFIT STATEMENT.

Interest on debentures	£8,179
„ „ temporary loans	1,622
To debit balance from previous year	756
Interest on advances accumulated during year ...	−5,613
Debit balance carried forward	−270
Gross profit	£4,674

In the West End undertaking the surplus on the year's work amounted to £51,135, to this was added sums of £10,651 and £21,082, balance and interest brought forward from the previous year, making a total of £72,868.

Out of this a sum of £10,000 was allotted to depreciation, being 1·47 per cent. on the capital liable to depreciation, a small amount compared with the considerable capital involved. The remaining surplus was distributed as shown, and a balance of £14,817 carried forward.

In the City undertaking, the balance from revenue account of £4,674 is supplemented by £5,613 interest on advances to Charing Cross and City Electricity Co. This enables the deficit from the previous year of £756 to be wiped off, provides for financial charges, and leaves a debit balance of £270, to go forward to the next account.

CITY NOTES.

Anglo-Argentine Tramways Co.

MR. H. DOUGHTY BROWNE presiding at the meeting of this company held at Cannon Street Hotel last week, said that they had had to meet certain electrical competition during the year, but in the second half they had the advantage of the electric working of portions of their own lines. They might congratulate themselves upon the increase in traffic therefrom, though the conversion involved considerable expense, and they had to employ electric traction experts. After paying the 4 per cent. which the Argentina Electric Traction Co, guaranteed, the directors were enabled to pay 4½d. a share in addition, and from January 1st of this year the shareholders would be in the receipt of a cumulative preference dividend of 5 per cent. It would have been a serious matter for the company to have taken upon themselves the electrification of their system, and, indeed, the Argentina Co. stated that the work had cost them nearly £800,000. He was persuaded that when the whole of the system was electrified and everything was working smoothly, there would be a very large increase indeed in the receipts. He was, moreover, informed that the calculations that were made by the Argentina Co. with reference to the reduction in the expenses were likely to be realised. If so, the surplus over the amount required to pay 5 per cent. on the existing shares would be very substantial.

Babcock & Wilcox, Ltd.

THE report for 1902 states that the net profit during the year, after deducting depreciation on plant, &c., amounts to £171,532. To this has to be added the balance brought forward from last account, £17,446, making a balance of £188,978. Interim dividends were paid last June of 3 per cent. on the preference shares, and of 7 per cent. on the ordinary shares, and it is now recommended that the following dividends be paid for the half-year ending December 31st, 1902, namely :—3 per cent. on the preference, 8 per cent. on the ordinary shares, bonus of 2 per cent. on the ordinary shares. There is placed to the reserve fund £50,000, and to the dividend equalisation fund £25,000, and a balance is carried forward of £17,878.

Perth (W.A.) Electric Tramways, Ltd.

MR. EDWARD HEASMAN presided at this company's meeting on 20th inst., and congratulated the shareholders upon the continued and progressive prosperity of their undertaking. The report showed that the profit for the 12 months ending December 31st, 1902, was very little less than that for the 18 months ending December 31st, 1901, and this with only a small increase in the mileage under operation. The greater part of the revenue in 1901 was earned from the operation of 13 miles, and that for 1902 from 16½ miles. A further section in Mount's Bay Road was just opened for traffic, and this would facilitate communication with South Perth, and make a total of of 17¾ miles running. The total receipts earned from January 1st to the 11th of this month amounted to £16,905, an increase of £1,596 over the corresponding period of last year. The ratio of expenses to receipts for the year under review was somewhat higher than for 1901, largely owing to increased price of coal. Notwithstanding this, the engineer reported that the actual expenses, including repairs and renewals, did not exceed 57 per cent. of the gross receipts. The increased earnings were principally due to increased population. They had acquired nine new cars of a much larger carrying capacity than those now in use. At present they were unable to order any additional cars, because they had exhausted their borrowing powers. The cars recently acquired they had been compelled to purchase on the hire system. Unless they obtained increased borrowing powers, the cost of additional rolling stock and the extension of the system would have to be provided out of revenue, and would mean the suspension of further dividends for some time to come. The directors thought the time had come when it would be prudent to ask for additional borrowing powers, so that the expenditure necessary to meet the increasing demands in connection with the growing traffic might be met out of new capital, instead of from the company's revenue. They were, therefore, to submit a resolution for the purpose of sanctioning an increase in the borrowing powers of the company up to a further £50,000. The carrying capacity of the new cars was nearly double that of those now in use. Some of the borrowing powers asked for would be utilised in connection with the extension of the system, but they only proposed to carry out such extensions as would be "feeders," and not "bleeders."

The report was adopted, and the resolution *re* borrowing powers was also approved.

Primitiva Gas and Electric Lighting Co., of Buenos Ayres.

THIS company met in London on Tuesday and passed the annual report. Mr. H. E. JONES, the chairman, said that there was a balance of revenue account of £103,251, as against £80,444 last year. £16,783 of the increase had gone for interest on debentures. On the question of depreciation of electrical works and machinery, which stood at £8,863, he said that the directors had had long and frequent discussions with the auditor. When he looked into the accounts of electric undertakings, he found it to be the exception rather than the rule to allow depreciation at all, but certain very prosperous electrical undertakings in London had on the average provided about 3 per cent. for several years past. The amount the directors had written off was calculated on that basis.

The adoption of the report was seconded by Mr. JOSEPH KINCAID, who gave some particulars respecting the electrical department. Their Buenos Ayres power station was situated in the centre of the consuming district, it had a plant capacity of 2,800 KW., which was ample for a largely increased demand. They were looking forward to being able to supply energy from this station at reduced charges

as the demand came on. The principal alterations carried out during the year were the completion of the additions to the machinery. The existing plant was capable of supplying a demand 25 per cent. greater than that now prevailing.

Oriental Telephone and Electric Co.

The directors' report for the year 1902, to be presented at the meeting on Wednesday, April 29th, says:—

The revenue account shows a credit balance of £12,789 17s. 6d. transferred to profit and loss. Including £2,975 1s. 10d. brought from 1901, and after deduction of £4,484 1s. 6d. paid as interim dividend on November 1st, there remains £11,280 17s. 10d. for disposal. The directors propose to pay a final dividend of 3½ per cent., making, with the interim dividend of 2½ per cent. already paid, 6 per cent. for the year, to transfer to reserve £3,000, and to carry forward £1,954 18s. 9d. The Bengal and Bombay Telephone Companies, in which the company is largely interested, have again declared dividends of 6 per cent. for 1902. The negotiations entered into with the Government of India for an extension of the Indian licenses granted to this and the above-named companies have now been brought to a conclusion. These new licenses will run for a period of 60 years, the Government reserving to itself the option to purchase the undertakings after the expiry of 20 years, or at subsequent periods thereto, on conditions which the board believe to be equitable to the shareholders. Negotiations have also been entered into with the Colonial Government at Singapore for an extension of the company's license there. The business of the Telephone Company of Egypt continues to expand, and that company has again paid the full dividend of 7½ per cent. on its preferential shares. The directors have taken up a further ten thousand pounds' worth of these preference shares, and have also made cash advances to that company towards the expenses incurred by it for cabling its system at Cairo and Alexandria and for the installation of telephone lines connecting certain villages in the provinces of Lower Egypt erected under agreement with the Government. During the current year the subscribers to the Egyptian Co.'s system at Cairo and Alexandria will be enabled to communicate with each other by means of trunk lines recently erected by the Government and which are being leased to that company. The China and Japan Telephone Co.'s branch at Hong Kong is continuing to make progress. The accounts have not yet been closed, but the company has paid interest on its debentures to December 31st: these are all held by your company. The electric lighting business is being worked to a profit, but, as stated in last year's report, its operations are restricted through want of larger working capital. Special opportunities of business offered themselves in 1901, but these were not forthcoming last year.

Cuba Submarine Telegraph Co.

The directors' report for the half-year ending December 31st, 1902, says:—

The total receipts of the six months, including the net amount recovered from the West India and Panama Telegraph Co. under the decision in the law suit against them, were £34,245 2s. 11d., while the expenses amounted to £6,099 15s. 10d., leaving a balance of £28,145 7s. 1d., to which has to be added £4,532 11s. 7d. brought forward from last account, giving a total of £32,677 18s. 8d. to be dealt with. The sum of £16,000 has been added to the reserve fund, which now stands at £145,000. The dividend on the preference shares will absorb £9,000, and leave £13,677 18s. 8d., out of which the directors recommend the payment of a dividend at the rate of 5 per cent. per annum and a bonus of 4s. per share on the ordinary shares, both free of income-tax; the balance, £6,477 18s. 8d., being carried forward to the current half-year. The cables have continued in good working order since the date of the last report. The company's claim against the United States Government for reimbursement of the cost of repairing the cables cut during the Spanish-American War, was passed by the Senate, but rejected by the House of Representatives on 4th ult. The matter will, however, be again brought to the notice of the Legislature when Congress next meets. Application has now been made by the company's representative to the new Government of Cuba, for payment of the subsidy of £2,000 per annum in respect of the coast cables, with the arrears from January, 1899, and the matter is being supported by His Majesty's Minister at Havana. There is every reason to hope for a favourable settlement.

Great Northern Telegraph Co., of Copenhagen.—The revenue account for the year 1902 (of which a copy has been sent us) shows traffic receipts, less loss on exchange, £455,550, and total receipts, including £64,872 brought forward, £546,544. The total expenses were £107,168. A final dividend is proposed of 15s. per share; reserve and renewal fund absorbs £55,556, renewal fund for cable steamers £16,667, pension fund £5,555, remuneration to the board £2,500, and dividend equalisation fund £105,000, £66,598 being carried forward.

Prospectus. — The list of applications closed on Wednesday in an issue of 4,000 £5 preference shares (6 per cent.), and £20,000 4½ per cent. first mortgage debenture stock in the Peterborough Electric Traction Co. The company is a B.E.T. concern, and has 5 miles (route) of electric tramways, the first portion of which was opened in January. Supply of energy is taken from the Corporation. 4,000 ordinary shares of £5 each have been already paid up. The nominal share capital is £60,000.

Oswestry Electric Light and Power Co.—Mr. Bremner Smith presided at this company's meeting on 10th inst., and moved the adoption of the report, which showed the available balance of profit to be £393, allowing a 3 per cent. dividend to be paid, and £170 to be placed to special reserve. £151 was written off for depreciation. The report was adopted.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in Automatic Telephone Co. (1903), Ltd.—4,000 preference shares of 2s. 6d. each, fully paid, Nos. 1 to 4,000; 324,368 ordinary shares of 2s. 6d. each, 2s. 2d. paid, Nos. 47,941 to 372,308; and 235,899 ordinary shares of 2s. 6d. each, fully paid, Nos. 372,309 to 608,207.

Calcutta Electric Supply Corporation. — The directors recommend a final dividend for the half-year ended December 31st at the rate of 7 per cent. per annum, making, with the interim dividend, 6½ per cent. for the year.

STOCKS AND SHARES.

Wednesday Evening.

Writing on the eve of the Budget announcement, it is possible that the details of that much-expected balance-sheet will make a sensible difference to the markets with which we deal. But at the moment, with Consols firming up again and the new Transvaal loan commanding about ⅞ per cent. premium over whatever may be the issue price, the Stock Exchange is in a rather better frame of mind than it has enjoyed for some time past. Before these lines are out it will have been seen whether the herald of the Budget is to take the shape of a reduced Bank Rate, but even if the old lady should not lower her minimum this week, there is little doubt that she will do so before long, although City merchants declare that the scarcity of available cash accommodation is still remarkable.

Business is again better in the departments wherewith we are concerned, and the traction market in particular finds its trade increasing daily. The sharp spurt in the stocks of the Argentine Railway section has drawn renewed attention to the attractions of Buenos Ayres and Belgrano Electric Tramway shares, attractions which have from time to time been suggested in these columns as worthy of consideration. The Ordinary shares are hard at 2⅞, and the "B" Preference at 5 are *ex* dividend, and arrears to the tune of half a guinea per share. The "A" Preference at 5¼ are also *ex* their interest, and the 5 per cent. First Debenture looks reasonably cheap at about 108.

London United Tramways Ordinary shares, after rising to 23 buyers, are about 15s. cheaper, but Dublins have hardened to 14. Calcutta Tramways remain firm at 7¼, and Anglo-Argentines have not moved from 4¼. It may be incidentally noted that London General Omnibus stock has risen to 92, while Road Car shares are 5¼.

Thanks to the Hampton Court extension of the London United Tramways Co., Central London stocks have advanced to a small extent, the Ordinary being a point to the good, and the Deferred 2 per cent. up. City and South London is dullish at 74. Metropolitan Consolidated has risen to 90 for the same reason which put up the quotations of Central London stocks, but Districts, funnily enough, are easier on the week at 39⅝. Business is being done in East London at 6¼, but Great Northern and City Preferred are neglected at 8½.

Four rises and one fall make the sum total of fluctuations to be recorded in our share list of electrical companies this week. Two of the improvements, it seems almost needless to say, are secured by Brompton and Kensington shares, whose steady progress nothing appears to stop. St. James's and Pall Mall Ordinary shares have also secured a rise, and the quotation is thereby restored to its level of a fortnight ago. The fourth advance falls to County of London first Debenture stock with a rise of 1. The recently offered second Debenture stock stand at par, and it will probably appreciate as time goes on. Blackheath and Greenwich Ordinary shed an eighth under the pressure of a few small sales.

In response to the many inquiries which are being made as to the advisability or otherwise of exchanging Brush shares for British Electric Tractions, it may be pointed out that the fewer Brush shares there become, so much the more contracted and narrow does the market grow. Few people care to hold shares which are not readily negotiable at all seasons, and the danger of being left with an unmarketable security is undoubtedly a potent factor to be considered by the perplexed Brush proprietor. On the other hand, it may well be that the time will come when there are so few Brush shares about that the remaining holders will be able to obtain a higher value from the British Electric Traction simply in order that the latter company may get all the Brush into its own hands. These are two of the chief points to be thought of in connection with the option. Brush Preference are down ¼, which begins and completes the tale of changes in the industrial division.

Speculation is again active in the stocks of the Anglo-American Telegraph Co., and on balance the Preferred and Deferred show small rises, allowing for the dividend deducted from the former. Several of the cable companies have secured offices in the new Baltic, to be opened within the next few days, and it is hoped that a lot of fresh business will accrue from this cause; but that remains to be seen, as we are told the boy said when he spilt the ink on the new carpet.

Commercial Cable stock is down 5 points, *ex* the 2 per cent. dividend, and Great Northern of Copenhagen shares have lost £1. Eastern Extensions are also weak, and the only sensible advance in this department is scored by Cuba Telegraph Preference shares, which are 10s. to the good. National Telephone Preferred at par middle has hardened a point, although the Third Preference shares at 5½ show a fractional fall. The fairly satisfactory Oriental report has caused no change in the quotation.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations April 15th.	Closing Quotations April 22nd.	Business done week ended April 22nd, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	97 —101	97 —101	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2¼— 3½	2¼— 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	61s.	60/6	49 — 52	48 — 51 xd	..	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	90 — 92	89 — 91 xd	91¼	90½
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	9⅜— 9½	9 — 9½	9⅜	9
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	..	4¼— 4½	4¼— 4½	4½	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	160 —170	155 —165 xd	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 92	89 — 92	90½	89½
16,000	Cuba Telegraph	10	4½%	4 %	6¾%	6½— 7½	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	13½— 14½	14½— 15½	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½— 3½	2½— 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
60,710£	Direct United States Cable	20	3½%	3½%	..	9 — 10	9 — 10 xd	9½	..
92,800£	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	116 —121	116 —121 xd	120	116
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	84 — 87	83 — 86	..	..
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	106 —109	106 —109	..	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11½— 12½	10½— 11½	11½	10⅝
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	105	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	101 —104 %	101 —104 %	..	..
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8½— 9	8½— 9	8⅝	8⅝
180,042	Do. do. 6 % Pref.	10	..	..	..	12 — 13	12 — 13	12	..
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	25 — 27	24 — 26	25	..
66,300£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	37 — 41	37 — 41	38½	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	100 —104	100 —104	..	..
72,680	Montevideo Telephone, Ltd., Ord. Nos. 1 to 72,680	1	2½%	2½%	..	⅛— ¼	⅛— ¼	..	..
86,492	Do. do. 5 % Pref., Nos. 1 to 86,492	1	..	..	..	¾— 1	¾— 1	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	98 —100	99 —101	100	99½
1,966,667	Do. do. Def. Stock	100	..	..	4½%	77 — 79	77 — 79	78⅜	78
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	13½	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	..	..
250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5¼— 5⅜	5 — 5½	5⅜	5¼
2,000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	97 — 99	97 — 99	99⅛	98
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	102 —104	..	..
171,504	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	¾— 1	¾— 1	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,839	Reuter's	8	5 %	5 %	..	6¾— 7½	6¾— 7½ xd	105	..
3,303	Submarine Cables Trust	Cert.	..	..	..	102 —112 xd	102 —112 xd	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¼— 5⅝	5¼— 5⅝	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4¼— 5¼	4¼— 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	105 —108	105 —108	..	..
15,609	West African Telegraph, Shares	10	..	..	..	3 — 4	3 — 4	..	..
30,008	West Coast of America, Nos. 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	0 — ¼	0 — ¼	..	..
150,000£	Do. do. 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	96 — 99	96 — 99	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 267,930	10	7 %	7 %	..	11 — 12	11 — 12	11⅛	11⅛
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	96 — 99	96 — 99	..	..
88,321	West India and Panama Telegraph	10	1%	..	..	⅛— ¼	⅛— ¼	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6½— 6⅝	6½— 6⅝	6⅝	6½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4 — 5	3½— 4½	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	3 — 4	3 — 4	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	75 — 80	75 — 80	75½	..
100,000	British Electric Traction	10	9 %	9 %	..	13½— 14	13½— 14	14	13⅝
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	12 — 12½	12 — 12½	12½	12½
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	122 —125 xd	122 —125	124½	123½
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	7¼— 8	8 — 8¼ xd	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½— 6¼	5½— 6¼	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	103 —107	103 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	12/6 to 18/6	15/— 18/6	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	16/6 to 17s.	16s. to 17s.	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	1⅝— 1½	1⅝— 1½	1⅝	..
150,000	Do. do. Non-cum. 6 % Pref.	3	6 %	3 %	6 %	1½— 2	1½— 1⅝	1⅝	1½
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	89 — 94	89 — 94	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	..	13 — 14	13 — 14	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼— 6	5¼— 6	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	108 —112	108 —112	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	104 —107	105 —108	108	107
494,093	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	103 —106	103 —106	105	104½
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	107 —110	109 —112	110½	110
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	75½— 76½	73 — 75	74½	73½
85,000	Crompton & Co., Nos. 1 to 85,000	5	8 %	7½%	..	2¼— 2⅜	2¼— 2⅜	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	102 —106	102 —106	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	2½%	Nil	..	1½— 2¼	1½— 2¼	..	..
944,028£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	73 — 77	73 — 77	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	75 — 80	75 — 80	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1¾— 2	1¾— 2	..	..
31,380	Do. do. 7 % Cum. Pref., 1 to 31,380	2	..	..	..	2¼— 3	2¼— 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	100—103	100 —103	..	..
25,000	General Electric Co.(1900), 5 % Cum. Pref.	10	5 %	5 %	..	10 — 10½	10 — 10½	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	99 —102	99 —102	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	15 — 16	15 — 16	15⅜	15½
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5½	5 — 5½	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18½— 19½	18½— 19½	18⅛	18½
300,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	1½%	1½%	5⅞— 6	5⅛— 5⅛	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10½— 11	10½— 11	..	..
7,500	Parker (Thomas), Ltd., Ord., Nos. 1 to 7,500	10	..	..	..	14½— 15½	14½— 15½	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	36 — 39	36 — 39	37½	36
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	97 —100	98 —101	..	..

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
§ From Bradford Share List.
¶ From Manchester Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, nil to 6d.
National Electric Free Wiring, ½—¾.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 14—15.
Do. do. Pref (£10 pd.), 9½—10½.

Bank rate of discount 4 per cent. (October 2nd, 1902).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations April 15th.	Closing Quotations April 22nd.	Business done week ended April 22nd, 1903. Highest.	Lowest.
		‡				⅜ — ½	⅜ — ½	..	..
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	1	..	..	..	..	..	..	..
100,000	.. Do. 4½% 1st Deb. Stock, Prov. Certs.	100	..	..	..	118 —121	118 —121	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	6 %	8 %	8 %	10⅛ — 10⅜	10⅛ — 11	10⅛	..
20,000	.. Do. do. 7 % Cum. Pref. ..	5	..	..	..	10 — 10⅛	10⅛ — 10⅜	10⅛	..
50,000	Charing Cross and Strand Electricity Supply	5	9 %	10 %	10 %	9 — 9⅛	9 — 9⅛	9⅛	9⅛
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4¾ — 5	4¾ — 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	105 —107	105 —107	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	5½%	4 %	4½%	6 — 6⅛	6 — 6⅛	6⅛	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —112	109 —112	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	0 %	5 %	5 %	10¾ — 11	10¾ — 11	10¾	10¾
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	..	..	13¾ — 14¼	13¾ — 14¼	14	13¾
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	122 —127	122 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	103 —106	103 —106	103¾	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	8 — 9	8 — 9	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	6 %	..	..	12 — 13	12 — 13	..	..
400,000‡	Do. do. 4½% Deb. Stock, Prov. Certs. (all paid) Red ..	..	..	..	..	109 —112	110 —113	111½	111½
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6⅞ — 7⅛	6⅞ — 7⅛	7	6⅞
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6⅛ — 6⅜	6⅛ — 6⅜	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	107 —110	107 —110	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	12 %	10 %	10 %	10¾ — 11¼	10¾ — 11¼	11¼	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	100 —103	100 —103	102½	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	2½ — 2⅝	2½ — 2⅝	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅝ — 6	5⅝ — 6	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red ..	Stock	..	..	..	100 —103	100 —103	102½	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6 %	6½%	7½%	17½ — 18½	17½ — 18½	..	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	110 —115	110 —115	..	..
260,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	98 —101	98 —101	..	..
10,852	Notting Hill Electric Lighting	10	7 %	6 %	6 %	14 — 15	14 — 15	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15½ — 16½	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	..	8½ — 9½	8½ — 9½	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	..	2½%	3 — 3⅛	3 — 3⅛	..	..
50,000‡	Do. do. 4% Deb.	100	..	..	..	88 — 93	88 — 93	..	..
65,000	South London Electricity Supply, Ord.	5	..	..	1½%	3¾ — 4	3¾ — 4	3¾	3¾
30,000	Urban Electric Supply, Ord.	5	..	..	..	4¼ — 5⅛	4¼ — 5⅛	..	..
30,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4¼ — 5⅛	4¼ — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	10½%	12 %	12 — 13	12 — 13	12⅞	12⅞
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6¼ — 6⅝	6¼ — 6⅝	..	..

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, April 22nd.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£23 15	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	5d.	..
a ,, Caustic (76/80%) ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	119/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 5	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£3	..
a ,, Bichromate, casks ..	per lb.	2¼d.	..

METALS, &c.		Latest Price.	Week's Inc. or Dec.
b Aluminium Ingots, in ton lots ..	per ton	£148	..
b ,, Wire, in ton lots ..	per ton	£294	..
b ,, Sheet, in ton lots ..	per ton	£191	..
p Babbitt's metal ingots	per ton	£43 to £145	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¼d.	..
c ,, Tube (brazed)	per lb.	9¼d.	..
c ,, ,, (solid drawn) ..	per lb.	8¾d.	..
c ,, Wire, basis	per lb.	7¾d.	..
c Copper Tubes (brazed)	per lb.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	10¼d.	..
g Copper Bars (best selected ..	per ton	£78	..

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£78	..
g ,, Rod	per ton	£78	..
c ,, (Electrolytic) Bars ..	per ton	£79	£1 dec.
c ,, ,, Sheets ..	per ton	£80	£1 dec.
c ,, ,, Rod ..	per ton	£79 10	£1 dec.
c ,, ,, H.C. Wire	per lb.	8¾d.	¼d. dec.
f Ebonite Rod	per lb.	3/-	..
f ,, Sheet	per lb.	5/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	3/10 to 3/11½	..
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	48/10	2d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanized No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£12 12 6 to £12 15	5s. dec.
g ,, ,, Sheet	per ton	£14 10	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 12 6	..
d Mica (in original cases) small ..	per lb.	8d. to 9d.	..
d ,, ,, medium	per lb.	1/9 to 2/9	..
d ,, ,, large ..	per lb.	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/2	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	10d. to 1/-	..
i Steel, Magnet, ace'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£127 to £129	£1 inc.
g ,, Foil	per lb.	1/6½	..
n ,, Wire, Nos. 1 to 16	per lb.	1/9½	..
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £65	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	7¾d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4½d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£26 15	..

Quotations supplied by:—a Messrs. G. Boor & Co.; b The British Aluminium Co., Ltd.; c Messrs. Thos. Bolton & Sons., Ltd.; d Messrs. F. Wiggins & Sons.; e Messrs. Frederick Smith & Co.; f India-Rubber, G.P. and Teleg. Works Co., Ltd.; g Messrs. Jame & Shakespeare; h Messrs. Edward [illegible] & Co.; i Messrs. Bolling and [illegible]; j Messrs. [illegible]; k Messrs. Morris Ashby, Ltd.; m Messrs. W. T. Glover & Co., Ltd.; n Messrs. P. Ormiston & Sons; o Messrs. Johnson, Matthey & Co., Ltd.; p The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Locality.	Week ending	Receipts for the week. £	Receipts for the week. £*	Total to date. £	Total to date. £*	Miles open.	*
Aberdeen	Apr. 18	570	+224	44,042	+11,446	—	—
Birmingham	,, 18	5,277	+485	78,404	+ 4,748	—	—
Blackburn	,, 10	1,054	+449	1,946	+ 195	12½	+1½
Blackpool and Fleetwood	,, 18	495	+417	4,015	+ 414	7½	—
Bolton	,, 19	1,867	+328	5,491	+ 1,303	—	—
Bristol	,, 17	5,515	+1 631	—	—	28	—
Burnley	,, 18	734	+ 63	—	—	—	—
British Elec. Trac. Co.:—							
Barnsley District ..	,, 10	194	—	2,320	—	—	—
Devonport	,, 10	543	+124	5,847	+ 107	5	—
Dudley—Stourbridge..	,, 10	780	+185	10,014	+ 6 4	18½	—
Gateshead	,, 10	941	+322	11,654	+ 2,529	10½	+ ¾
Gravesend—Northfleet	,, 10	224	—	2,581	—	3½	—
Greenock—Pt. Glasgow	,, 10	473	+ 20	5,997	+ 480	7½	—
Hartlepool	,, 10	2-7	+ 58	3,174	+ 462	6½	+2
Kidderminster	,, 10	115	+ 23	1,431	+ 24	4½	—
Mershyr	,, 10	221	+ 51	2,520	— 29	8	—
Middleton	,, 10	384	+109	3, 3	— 96	8½	—
Oldham—Ashton ..	,, 10	656	+211	7, 92	+ 761	8	—
Peterborough	,, 10	191	—	1,489	—	—	—
Poole	,, 10	315	+ 98	3,986	+ 324	3½	—
Potteries	,, 10	1,598	+257	21,485	+ 1,-10	29½	—
Rothesay	,, 10	78	+ 24	691	+ 174	—	—
Southport	,, 10	337	+126	3,229	+ 1,043	6½	—

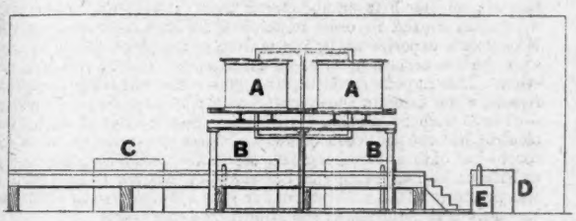
Locality.	Week ending	Receipts for the week. £	Receipts for the week. £*	Total to date. £	Total to date. £*	Miles open.	*
B.E.T. Co. (*continued*)—							
South Staffordshire ..	Apr. 10	789	+133	10,189	— 945	21½	—½
Swansea	,, 10	543	+134	6,336	+ 397	5½	—
Taunton	,, 10	59	+ 6	726	— 64	1½	+½
Tynemouth	,, 10	335	+128	3,118	+ 282	3	—
Weston-super-Mare..	,, 8	41	—	331	—	2	+½
Wolverhampton Dist.	,, 10	394	+264	4,940	+ 2,755	10	+8
Wrexham	,, 10	231	—	231	—	—	—
Yorks. Woollen Dist..	,, 10	233	—	1,299	—	6	—
Cardiff	,, 18	1,979	+1305	4,948	+ 3,070	—	—
Dover	,, 20	220	+ 35	2,850	+ 44	3	—
Dublin	,, 17	5,118	+567	66,686	+ 3,904	46	—
East Ham	,, 18	725	- 286	1,868	+ 662	5	+ ½
Glasgow	,, 11	12,2.7	+2.7	553,866	+23,300	68	+1½
Isle of Thanet	,, 18	635	+135	4,267	+ 498	—	—
Leeds	,, 18	5,843	+1231	18,408	+ 2,2 0	—	—
Liverpool	,, 11	10,418	+1520	140,311	+ 7,5.5	101	+5
Manchester	,, 18	12,009	—	—	—	110	—
N. weastle	,, 18	3,91	+928	—	—	17	—
Portsmouth	,, 18	1,-70	+555	—	—	29	—
Sunderland	,, 19	1,135	+ 49	3,154	+ 197	12	—
Central London Railway	,, 18	7 454	+ 6?7	111,930	+ 5,973	6½	—
City and S. London Ry.	,, 19	3 064	+254	50,816	+ 3, 7+	6	+½
Liverpool Overhead Ry	,, 19	1,8.8	+378	24,567	+ 2,146	6½	—

* Compared with the corresponding period of 1902.

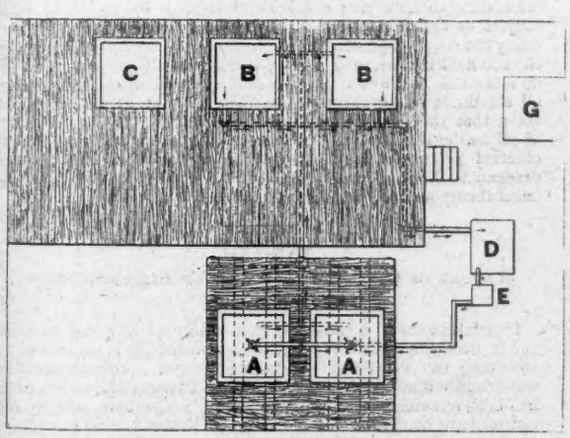
SOME NOTES ON ELECTRO-GALVANISING.

By SHERARD COWPER-COLES.

Electro-zincing is being extensively used in ship-building yards for coating steel plates and boiler tubes. The first plant was erected about 10 years ago at the ship-building yard of Messrs. Laird Bros., at Birkenhead. The results obtained have been highly satisfactory when the work has been electro-zinced under proper supervision, in a plant capable of fulfilling the conditions necessary to obtain an adhesive coating of zinc free from perforations. Electro-galvanised steel test plates that had been exposed to the weather in a manufacturing district for over five years, when examined, showed little or no signs of deterioration; on the other hand, if the work had not been zinced in a proper manner, the coating obtained would have possessed no protective value, and signs of rust would have shown in a few months after exposure to the weather. Iron, when dipped in a bath of molten zinc, cannot have less than a given amount, about 1 oz. of zinc per square foot (except in the case of sheets and wire where the zinc is wiped off by mechanical means), the thickness of the coating depending upon the temperature of the zinc, and the rate at which the iron is withdrawn from the molten zinc. Work to be cold galvanised may be placed in the bath for an hour or more, and be withdrawn with practically no zinc on it, due to a bad electrical connection, or too high resistance, or to the bath being too acid.



Elevation.



Plan.

General Arrangement of Cowper-Coles Electro-zincing Plant for Messrs. H. Tate & Sons.

On numerous occasions work has been shown to the writer which has had a good appearance, but which, when tested, was found to be only coloured or flashed with zinc, due to a bad connection or the bath being too acid, or the dynamo of too small a capacity for the size of the work under treatment. Work of this class is bringing the process of electro-galvanising into disfavour with many engineers; but if the work is electro-galvanised under proper supervision, and in a plant which embodies all the conditions that have been found necessary to success, the results obtained are excellent, and for some classes of work are superior to hot galvanising.

The Admiralty specifies that all boiler tubes should be coated externally with a coating of zinc equal to 1½ oz. per square foot, and that economiser tubes should be coated inside and outside with an equal thickness. Electro-galvanising is tested by the Post Office or Preece's test, *i.e.*, by dipping the zinced iron into a saturated solution of copper sulphate for one minute when the test piece is removed, wiped and replaced. This is continued until a red adhesive deposit of copper is obtained, showing that the iron is exposed. For adhesion, the usual bending tests are applied.

Mr. C. Richter has given much attention of late to the testing of iron and steel electro-galvanised, and hot galvanised; he has drawn up a table, published in the *Electrochem. Zeits.*, 1902, and suggests that comparisons should be instituted between the following five groups of properties:—

A.—Geometrical and optical properties of the metallic film, comprising (1) form; (2) colour; (3) lustre.

B.—Mechanical properties of the film with, and without, reference to the material coated, comprising (4) hardness; (5) continuity; (6) elasticity; (7) tensile strength; (8) adhesion.

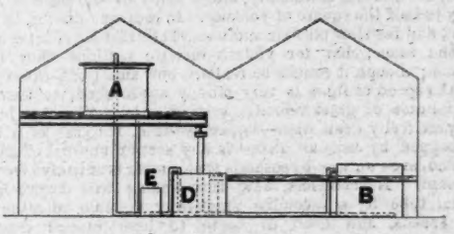
C.—Chemical and electro-chemical properties of the plating with, and without, reference to the object plated, including (9) chemical composition; (10) power of resisting corrosion; (11) protective power.

D.—Thermal properties (12) coefficient of contraction and expansion.

E.—Change in properties of the plated material (13) any alteration in the properties of the material after treatment.

Experience has shown that for an electro-zincing plant to give continuous and satisfactory results, it must be so arranged that it is practically automatic and can be placed in the hands of any intelligent workman. These conditions have been successfully filled by doing away with zinc anodes and substituting insoluble lead anodes and replenishing the zinc deposited from the electrolyte by passing it over filter beds containing zinc powder or dust.

One of the the most recent plants that have been erected in this country, is for Messrs. Henry Tate & Sons, Ltd., sugar refiners, of Silvertown, London, E. The plant consists of two electro-zincing tanks marked B on the illustration, 6 ft. × 5 ft. × 5 ft. deep, which are constructed of wood and lead lined, the solution being heated by means of lead steam coils. Washing tank C of the same dimensions is placed near the zincing tanks in which the work is dipped after removal from the zincing tanks. The electrolyte, which is composed of zinc sulphate solution, is circulated through the zincing tanks by means of pump E, the solution being led from the overflow of the zincing tanks B, into the sump D, and from



End Elevation.

A, Two regenerating tanks; B, Two zincing tanks; C, Washing tank; D, Sump; E, Pump; G Engine and dynamo. Scale $\frac{1}{16}$" = 1 foot.

thence it is pumped to the regenerating tanks A A, and sprayed over filter beds consisting of zinc dust mixed with finely divided coke. In practice it is found very important to keep the zinc solution slightly acid, otherwise the zinc coating will not be adhesive, and will have a tendency to blister. The best proportion of free sulphuric acid is about $\frac{1}{10}$ oz. of free sulphuric acid to every gallon of water. The amount of free acid in solution is quickly determined by the workman in charge by using gelatine capsules containing a low percentage of alkali. A small proportion of lacmoid solution is then added and the condition of the solution readily determined by colour tests.

Messrs. Henry Tate & Sons, Ltd., sand-blast all their work before electro-galvanising, as a good deal of it consists of hollow steel work which is liable to retain some of the acid if placed in a pickling tank and finally cause corrosion. The dynamo gives a current of 2,000 amperes, and an E.M.F., of 8 volts. Such a plant can be worked continuously for months without the necessity of stopping for cleaning out the tanks or to renew the anodes, as the solution is constantly being filtered by passing through the filter beds containing zinc dust. So long as the filter beds are kept replenished with zinc dust the plant requires no further attention beyond the occasional stopping of the pump if the solution is found to be getting too neutral. The use of zinc dust in place of zinc anodes is found to effect a considerable economy. Zinc anodes do not dissolve freely, and soon become disintegrated and fall to pieces, rendering the electrolyte foul and the deposit of zinc rough. Thin sheet lead anodes which are used in combination with the zinc dust also have the advantage of being pliable, so that they can be readily bent to the contour of the variously shaped articles required to be electro-galvanised.

INSTITUTION OF ELECTRICAL ENGINEERS.

ON ELECTRONS.

By Sir Oliver Lodge, F.R.S., Vice-President.

(*Paper read in London, November 27th, 1902.*)

(*Continued from page* 616.)

APPENDIX TO PART VI.

Appendix K.

Note on the Behaviour of a Charge Moving Nearly at the Speed of Light.

Mr. G. F. C. Searle has kindly called my attention to a paper of his in the *Philosophical Magazine* for October, 1897, and maintains that a charge does not re-distribute itself on a moving body when

its speed becomes great, but that the lines of force bend or are deflected towards the equator, without remaining normal to the surface whence they start. And I see that Mr. Heaviside in his "Electrical Papers," Vol. 2, p. 514, accepts this result, and considers that we have no guarantee that at these high speeds lines of force are necessarily normal to conducting surfaces; an assertion in which we may trace some analogy to the fact that in a moving medium rays of light are not perpendicular to their wave fronts.

There is no question but that the lines of force bend back towards the equator, as stated by me in Part I., but I assumed that this deflection of the lines would entail their moving up nearer to the equator of the sphere, so as to leave the poles bare of charge, in order that they might still continue radial. I admit that the lines of force need not continue radial, but it seems to me that there is still some redistribution of the charge as the speed increases; a fact, however, which is not important. Mr. Searle calculates that whereas a sphere at rest acts as if its charge were at a central point, this equivalent point opens out into a uniformly charged line, forming a medial and small portion of its diameter, when the sphere is in motion; the length of the line gradually increasing until the speed equals that of light, when it fits the sphere exactly. But this neglects a distortional change in the sphere itself, to which I will presently refer.

The fact is that the whole subject of the behaviour of a charged body moving at enormous speed is a complicated one, and directly you get within 20 per cent. of the speed of light it begins to be necessary to consider even its inertia, as well as its deflecting force, in a more thorough and elaborate manner.

Mr. Searle points out that three different estimates of inertia can be made—one as the ratio of force to acceleration, another as the ratio of momentum to velocity, and a third as the ratio of kinetic energy to half the square of velocity. In ordinary matter, as is well known, and for slow electric motions, these three estimates are one and the same; but for violent electric motions they become different; though it should be realised how small the difference is, until the speed of light is very closely approached, so that in no material case of great velocity or great acceleration that has ever been practically dealt with—as, for instance, the case of a cannon ball stopped by armour plate—is any sort of unusual effect to be expected, even on the hypothesis that matter is entirely electrically composed. Nevertheless, now that among free corpuscles in a vacuum tube it is becoming practically possible to attain these high speeds, and even to begin to base crucial determinations upon them, it becomes necessary to consider the matter more carefully. And in a book published at Göttingen in January, 1902, Dr. Abraham discriminates what he calls "longitudinal" from what he calls "transverse" inertia; making inertia depend not only on the speed of motion, but on the direction in which the body is being accelerated.

And all these results are still further complicated by a consideration of the effect of acceleration itself, which, whenever it is violent, gives rise to some perceptible radiation, involving dissipation of energy; and this radiation loss of energy, though it will be primarily represented in the motion as a resistance or velocity term, may secondarily have an effect on inertia; probably, however, quite a small and subordinate effect in all practical cases, and no effect at all, so long as motion occurs with uniform speed in a straight line; for then there is no radiation. But then, of course, under those conditions it is not possible to test or measure the inertia of a body; it is only when the motion is either curved or changed in some way that inertia becomes prominent, and then there is necessarily some, though usually very small radiation, too.

A convenient expression for the inertia of a body moving at any speed is hard to arrive at. A variety of expressions have been given, and some of them are contained in the first chapter to J. J. Thomson's "Recent Researches in Electricity and Magnetism," but they are not attractive, and it appears from Mr. Searle's results that it is only under very careful qualifications that they apply. For these reasons I do not propose to enter upon a discussion of them further than may be necessary to criticise or appreciate Kaufmann's recent experimental attempt at basing an important measurement on these high velocities, by observing the electric and magnetic deflections then exhibited by cathode rays, so as to obtain, if possible, their modified m/e ratio at ultra high speeds.

When magnetic deflexion is being observed at ultra-high speeds we have also to remember that it is possible for the ordinary expression for the force exerted on a current by a moving field to be departed from.

The ordinary expression for deflecting force is $e\,u\,\mathrm{H}$ at low speeds, for a charge e moving at speed u across a magnetic field of intensity H; but at higher speeds an expression of much more complicated character is investigated by J. J. Thomson in the first chapter of his "Recent Researches in Electricity and Magnetism," and is obtained in the following form:—

$$e\,\mathrm{H}\,\frac{v^2-u^2}{u}\left(\frac{v}{2u}\log\frac{v+u}{v-u}-1\right).$$

This, however, at low speeds reduces not to the usual simple value, but to one-third of that value, viz., $\frac{1}{3}\,\mathrm{H}\,e\,u$; and Prof. Schuster in the *Philosophical Magazine* for January, 1897, calls attention to the variety of numerical estimates of this quantity given by different varieties of the main theory.

Abraham's value of what he calls "transverse inertia" is quoted by Kaufmann in *Comptes Rendus*, Vol. 135, p. 577, writing it with m_0 as the equivalent inertia for slow motion, and with β as the ratio u/v—the ratio of the speed of the motion to the velocity of light—thus

$$m = \frac{3\,m_0}{4\beta^2}\left(\frac{1+\beta^2}{2\beta}\log\frac{1+\beta}{1-\beta}-1\right)$$

and this is the formula employed by Kaufmann for experimental test and verification.

Mr. Heaviside gives a still more complex expression—"Electrical Papers," Vol. 2, p. 514—for kinetic energy; viz. an expression equivalent to $\frac{1}{2}\,u^2$ multiplied by the following quantity,

$$\frac{\mu\,c^2}{a}\cdot\frac{1-r}{4\,r}\left(1+\frac{2\,r-\frac{1}{2}}{1-r}+\frac{(2\,r-\frac{1}{2})\tan^{-1}\sqrt{\left(\frac{r}{1-r}\right)}}{\sqrt{\{r(1-r)^3\}}}\right)$$

which therefore may be taken to represent the inertia for that case, r being the squared speed ratio u^2/v^2.

Larmor treats the whole matter from a general point of view in *Phil. Trans.*, 1895, p. 717, and shows that no mere acceleration term is sufficient to express completely the reaction to applied mechanical force.

Distortion due to High-speed Motion through the Ether.

In Mr. Searle's paper in the *Philosophical Magazine*, October, 1897, he points out that the simplest charged body when in motion is not a sphere, but an oblate spheroid, oblate in the direction of motion, with its axes in the ratio $\sqrt{\left(1-\frac{u^2}{v^2}\right)}, 1, 1$; and that this produces on all points outside itself exactly the same effect as a point charge at its centre, and that therefore such a spheroid in motion at the speed u takes the place of the sphere in electrostatics. He calls this a Heaviside ellipsoid, because Mr. Heaviside first indicated its importance in the theory of moving charges.

But I wish to point out that a spheroid of this kind is exactly what a sphere in sufficiently rapid motion would automatically become, on the Fitzgerald-Lorentz theory; viz., that hypothesis which was started in order to account for the negative result in Michelson's experiment by postulating a change of dimensions in solid bodies according to their direction of motion through the ether. This hypothesis became a definite theory giving important results, when Lorentz showed that on the electric theory of matter—or even without assuming that the whole inertia of matter was electric, because the result is not a question of inertia, but of static force—not only was such a change of dimensions reasonably likely, as Fitzgerald had perceived, but that the change to be expected was precisely of the right amount to give a compensating effect and precisely zero resultant in the Michelson experiment.

The change of dimensions thus imagined and justified is gradually coming to be accepted as plausible and probably true; and it is interesting to note that a sphere in motion, by reason of being subject to this amount of distortion, still retains its property of being the simplest geometrical body, so far as the distribution of its electric field is concerned. True, it is then no longer a sphere; but no measuring instrument could possibly show its distortion, because all standards of measurement would share it. It is a remarkable thing that this imperceptible and unmeasurable uniform distortion of all matter should ever have been discovered: nothing but an ethereal process could have dragged it to light. Nevertheless dragged to light it has been, by the combined testimony of electrical theory and of optical experiment.

PART VII.

Summary of Other Consequences of Electron Theory.

Radio-Activity.

If many atoms of a substance have electrons attached to them, and if these are performing orbital revolutions, it is natural to ask how then can it be that substances are not constantly emitting waves and radiating away their energy. Fortunately, owing to the brilliant researches of Becquerel, Curie, and others, certain substances have been found in which the radiation intensity reaches a very perceptible magnitude; and it appears that this radiation may be of several kinds—

1. Of waves or pulses analogous to Röntgen radiation, probably;
2. Of rays analogous to Lenard, or cathode rays, consisting of electrons and ions bodily shot off, certainly;
3. Of detached portions of the substance itself not charged with electricity, but emanating like an odour, and possessing like the rest of the substance an intrinsic radiating power, and capable of attaching itself to other materials in the neighbourhood, so that they too acquire temporary radiating power.*

The substances which possess any noteworthy amount of this radiating power are substances with very high atomic weight, and their emitting power would appear to be probably due to an internal commotion and collision between the atoms, of sufficient violence to detach, and as it were evaporate every now and then, some of the smaller particles; and also by the shock of the collisions to generate some feeble Röntgen rays.

It is easy to grant that whenever there are actual collisions of sufficient suddenness some radiation of this kind must be emitted; but we cannot help asking, why does not the quiet orbital revolution of electrons round atoms, in a substance not in a high state of thermal disturbance and not possessing specially massive atoms, why does not this also give rise to a perceptible amount of radia-

* See, for instance, papers by the original discoverer, M. Henri Becquerel, in *Comptes Rendus*, 1896 and 1897; see also Rutherford, *Phil. Mag.*, January, 1899 and 1900, with quantitative determinations concerning it. Also in *Phil. Mag.*, July and November, 1902. Other references are M. and Mdme. Curie, *Comptes Rendus*, November, 1899; Hon. R. J. Strutt, *Phil. Trans.* A 1901, vol. 196, p. 525; Sir W. Crookes, *Proc. Roy. Soc.*, vol. 66, p. 409 (1900), vol. 69, p. 413 (1902), also "Electrical Evaporation," 1891, *Proc. Roy. Soc.*, vol. 50, p. 88; and many other workers.

tion and loss of energy? One answer that has been given is as follows:—

The radiators are not isolated or independent, and surface radiation is maintained by layers at greater depth in the substance. Moreover, the radiators are so close together that they are in all sorts of phases within the first quarter wave length, a length which embraces a multitude of them; wherefore a multitude is a worse radiator than one, because they interfere and produce but little external or distant effect; like the two prongs of a fork, or two neighbouring organ pipes, or the front and back of a vibrating wire. See Larmor, "Ether and Matter," page 232. But I doubt if much answer is wanted, save one of a very different character, viz., that radiation of a low temperature order is, as a matter of fact, always going on from all substances; that energy is conserved, and constancy of temperature persists merely because loss is equal to gain, because absorption compensates radiation, not because radiation ceases; and that, to make an estimate of the amount of radiation so occurring, it would be necessary to suppose the body in an enclosure at absolute zero; when undoubtedly its kinetic energy *would* rapidly leak away, and be dissipated. The whole subject of radio-activity is a large one, upon which I do not propose to enter here and now. Suffice it to realise that any difficulty of explanation in connection with it is not the fact itself, but rather why it is not more notorious.

However, so far as the most striking and interesting excessive photographic and electric radio-activity of certain rare substances is concerned, it has been already hinted that the greater part of that does not consist so much in the emission of radiation proper—whether in the form of pulses of X-rays or any other form—as in the flinging off of particles, negatively charged particles or electrons as a rule, but sometimes, according to Mr. R. J. Strutt, of positive ions also. The faint photographic influence of ordinary substances observed by Dr. W. H. Russell seemed to suggest that incipient power of this kind is not limited to bodies with heavy atoms like uranium, radium, polonium, &c., as described by Becquerel and the Curies, though these substances show it to an extraordinary degree: Dr. Russell, however, appears to have traced his at first interesting effects to the merely chemical action of hydrogen peroxide.

The whole subject, together with the allied one of the loss of charge from hot bodies,* first discovered by Dr. Guthrie long ago (see *Phil. Mag.* [4], xlvi. p. 273), is one that demands special attention and treatment, for which there is no opportunity now.

Solar Corona, Comets' Tails, Magnetic Storms, and Auroræ.

Another subject on which it is tempting to enlarge is the explanation of various astronomical and meteorological phenomena by the electron theory.

The theory of Auroræ has recently been elaborated by Arrhenius; but the whole doctrine of emanations from the sun, and of repulsion of small particles both by his light and by his probable electrification, is a matter that has been familiar to me for several years, through conversation with Fitzgerald and others. See, for instance, Larmor, *Phil. Trans.* 1894, vol. 185, p. 813; Lodge on Sunspots, Magnetic Storms, Comets' Tails, Atmospheric Electricity, and Auroræ, in the *Electrician* for December 7, 1900, vol. 46, p. 250; Fitzgerald, *Electrician*, December 14, 1900, with reference to a communication on the subject in 1893 (see the *Electrician* for August 11, 1893). See also his collected "Scientific Writings," at date 1882.

The earth is, in fact, a target exposed to cathode rays, or rather to electrons emitted by a hot body, viz, the sun. The gradual accumulation of negative electricity by the earth is a natural consequence of this electron bombardment, and the fact that the torrent of particles constitutes an electric current of fair strength gives an easy explanation of one class of magnetic storms; which have been long known, by the method of concomitant variations, to be connected with sunspots and auroræ. The electric nuclei would also serve as centres for condensation of atmospheric vapour at high altitudes and so be liable to affect rainfall.

Nevertheless, it is true that these theories have been well elaborated of late by Arrhenius; and his explanation of the aurora by means of the catching and guiding of rapidly moving electrons by the earth's magnetic lines of force, so as to deflect them from the tropics and conduct them in long spirals, along the lines, to the poles, there to reproduce the phenomena of the vacuum-tube in the rarified upper regions of the atmosphere, is particularly definite and pleasing. Some of the other astronomical suggestions he has made are likewise of considerable interest.

(To be concluded.)

* See, for instance, Strutt on leakage from hot bodies, *Phil. Mag.*, July, 1902; J. J. Thomson, ditto, *Phil. Mag.*, August, 1902.

Manchester Section.

The paper on "Comparison between Steam and Electrically-driven Auxiliary Plant in Central Stations" by Messrs. C. D. Taite and R. S. Downe, postponed from March 17th, was read on April 7th by Mr. Downe. The authors gave the following list as embracing the auxiliary plant coming within the scope of their paper:—Air pumps for condensers; cranes; feed pumps; mechanical stokers; economisers; coal elevator; ash conveyor; and workshop; and proceeded to point out the disadvantages arising from the use of steam-driven plant as compared with that electrically driven. One great point in favour of electric driving is the readiness with which the power taken by any portion of the plant, at any time, may be ascertained, thus providing a means whereby waste of power may be prevented, as any increase in power required is at once seen and the cause investigated. A table was given showing in detail what percentage of the total units generated in the Salford power station is taken by the auxiliary plant. The total percentage is 6·5; of this the condensing plant takes 4·67, boiler feed pumps 1·18, stokers 0·37, ash conveyor 0·07, economiser scrapers (1,600 pipes) 0·11, coal elevators 0·05, workshop 0·05. The engine room crane takes an amount so small as to be negligible.

The points then considered by the authors were, taking the case of boiler feed pumps—(1) Reliability; (2) Economy in working; (3) First cost; (4) Upkeep.

Regarding No. 1 the authors think both steam and electric plants are satisfactory. In considering No. 2, however, they are of opinion that the electric plant is much superior, and particulars were given showing pounds of water delivered per pound of steam used under ordinary working conditions at the Southport and Salford stations respectively.

On the question of first cost the steam-driven pump has an advantage, the price being only about one-third that of an electrically-driven one, but experience seems to show that the former absorbs more power. The fourth point, upkeep, is balanced again, both types of plant being equally satisfactory in this respect.

Figures relating to power required, and other particulars, were then given for condensers at Salford and Southport, and finally for a motor alternator at Salford.

In opening the discussion, Mr. Chattock said the electrically-driven plant spoken of in the paper seemed very economical, but he thought that its reliability would not be so great as to warrant depending on motors entirely, and he advocated spare steam plant.

Mr. Chorlton thought electric motors quite satisfactory, and gave some results of tests on a recently designed variable stroke pump driven by a motor; the tests were made after several months' working, and the efficiency at full load was 75 per cent. and at half load 69 per cent.; the combined efficiency of motor and gearing was at full load 89 per cent. and at half load 78 per cent.

Dr. Rhodes remarked that first cost and upkeep were simply appendages of economy, and that taken all round economy seemed to point to electric driving. He wished that information was available showing losses in steam pipes connecting boilers to auxiliary engines, and pointed out that as much as 10 per cent. was sometimes lost in this way, whereas in electric driving the loss was practically nil.

Mr. Cowan thought that losses in steam pipes counted for a great deal, and suggested driving the auxiliary plant (as is done on torpedo boats with high speed engines) direct from the main engines in order to obtain the very highest possible efficiency.

Several other members present also expressed their views, which in the main favoured electric driving.

The Chairman (Mr. H. A. Earle) considered there was a very great advantage with electrically-driven plant in the ready means of measuring power required, and thought economisers and stokers, &c., ought certainly to be driven by motors as an example to the consumers.

The authors then gave a brief reply to each gentleman's remarks and a hearty vote of thanks proposed by the Chairman, and seconded by Mr. Cowan, was passed.

The annual general meeting of this section was held on Tuesday last, April 21st, when a paper was read by Mr. A. H. Gibbings, M.I.E.E., on "The Carriage of Goods on Electric Tramways" (illustrated by lantern views).

MODERN TENDENCIES IN THE UTILISATION OF POWER.*

By J. J. Flather.

(Concluded from page 675.)

It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal or long-distance transmission is not encouraging; while the development of the Texas and southern California oil fields has increased the visible supply and brought about increased activity in the use of liquid fuel, yet it is doubtful whether the advantages would be sufficient to cause it to come into general use as a fuel, since with a limited production and an increased demand for this and other purposes the cost would be correspondingly increased.

A number of railroads contiguous to the oil-producing centres have equipped their locomotives to burn this fuel, and it is used to some extent to fire marine boilers, and with great satisfaction, since its displacement for a given heating value is only about one half that of coal, and the labour cost is materially reduced.

It is also used quite extensively in certain sections of the country as a steam producer in power plants, but it is hardly probable that liquid fuel will be a serious competitor of coal, notwithstanding its many advantages. At the present time, as far as power for manufacturing plants is concerned, it is largely a question of transportation, whether oil can be laid down and handled at a given point more cheaply than coal. It is probable, however, that oil fuel will supply a local demand in certain sections where transportation

* Address of the chairman of Section D, Engineering and Mechanical Science, and Vice-President of the American Association for the Advancement of Science. Read at the Washington meeting, December 29th, 1902.

charges, and possibly insurance, will permit its use at a low cost, and it is in this connection that it may become a competitor of electrical transmission.

One interesting phase of the power problem which forcibly presents itself to the engineer at the present time is the vast possibilities possessed by the modern combustion engine, which includes the various types of gas and oil engines. While its use as a motor in industrial establishments has been somewhat limited, yet there is a marked tendency to employ the gas engine in manufacturing works, and a consideration of its advantages and cost of operation, together with its high thermal efficiency and possibility of still further improvement, indicates that, for a great many purposes, both steam engines and electric motors may be ultimately replaced by gas engines.

While the first cost of electric motors in the smaller sizes is considerably less than the cost of well-made gas engines for similar capacities, the saving during the first six months of service, due to the more economical operation of the gas engine, will often more than compensate for the difference in first cost.

That the gas engine, in both large and small sizes, has reached a point in its development where it can fairly rival the steam engine in reliability and satisfactory running qualities, there can be no question. In point of fuel economy, a gas engine of moderate size is on a parity with the largest triple expansion steam engines, and will give a horse power on less than one pound of fuel.

The high price of gas in this country has contributed largely to those causes which have prevented a more common use of the gas engine as a motor. For this reason the gas engine has generally been used, not so much because of its high efficiency as a thermo-dynamic machine, but rather on account of its convenience and saving in labour. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available.

It is to producer gas that we must look for any marked increase in the use of the gas engine. Fortunately, the manufacture of producer gas has reached a high state of development, and there are now in successful use several processes by which power gas can be made from cheap bituminous coals as well as anthracite and coke. The leanness of such gases renders them less effective per cubic foot of gas, as compared with the richer coal gas or even water gas; but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas engine as a general motor depends.

A prominent factor in gas engine practice which has attained a high degree of development in European practice is the small gas producer. These generators are very simple in operation, and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. Generally small anthracite coal or coke is used, but several methods employ bituminous coal, lignites or wood. With bituminous coal, means must be provided for removing the tar and ammonia and other products of distillation.

The process of generation in some of the more recent producers is entirely automatic, and depends upon the demand of the engine, so that no storage capacity is required. The economy of these small producers is shown by tests, which give 1 H.P. on a 16-H.P. engine with a consumption of only 1·1 lb. of fuel. For engines above 40 H.P., 1 H.P. can be obtained on ¾ lb. of fuel.

The gas engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilised direct in combustion engines without the intervention of boilers, and without any special purifying processes. A still more important circumstance, which is far-reaching in its results, is the fact shown by Prof. Hubert, of the Liége School of Mines, that the superior economy of the gas engine enables equal power to be obtained with 20 per cent. less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines in this way utilises vast sources of power which a few years ago were allowed to go to waste, or, at most, were used very inefficiently.

The high thermal efficiency of the gas engine has long been recognised, and the possibility of further development is a promising factor in this field. The already accomplished efficiency of 38 per cent. reported by Prof. Meyer, of Göttingen, greatly exceeds the maximum theoretical efficiency of the steam engine and more than doubles its actual best obtainable working efficiency, but the end is not yet.

With higher compression even greater efficiencies may be expected. But with high compression there is danger of premature explosion, due to the generation of heat in compressing the gas in the presence of oxygen; for this reason Herr Diesel compresses the air separately. Under a pressure of 500 lbs or more, which is used in the Diesel motors, the air becomes very hot and readily ignites a charge of liquid fuel, which is injected into the compression chamber. There is no explosion; combustion occurs while expansion goes on and the heat generated disappears in the form of work.

Efficiencies of 30 per cent. or more have been obtained with blast furnace gases, which contain a very small percentage of hydrogen, and this with the high rates of compression which can be carried has led to the advocacy of non-hydrogenous mixtures in large engines. Certainly very high rates of compression may be had with a non-hydrogenous producer gas without fear of premature ignition, and it has the additional advantage of economical production.

The practice of making the cylinder in combustion engines act alternately, first as air compressor then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

The danger of pre-ignition and consequent severe shock on the engine also necessitates very heavy construction in the smaller engines in order to obtain a reasonable degree of safety in operation. Moreover, the smoothness of action is greatly retarded with this form of engine, especially if the governing is controlled by the "hit-and-miss" method, in which the regulation is effected by varying the frequency of the explosions, thus causing great variations in the driving torque.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engine have been increased rather than decreased. Notwithstanding these well recognised defects in the four-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas engines.

More recently very satisfactory results have been obtained in the construction of two-cycle engines. In some of these we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition, and this permits smaller clearance spaces with attendant advantages.

If the engine is single-acting, an impulse is obtained every revolution, which thus ensures better speed regulation, as well as double the power for a given sized cylinder.

The highest thermal efficiency yet attained, namely, 38 per cent., has been secured with a two-cycle type of engine which compresses the air and gas in separate pumps to a nominal pressure of 8 or 10 lbs.; the air under this pressure being used to scavenge the cylinder toward the end of expansion. After the unconsumed products of combustion have been forced out by the fresh air, the cylinder walls having been cooled thereby, a charge of gas is admitted and compressed to a pressure of 150 to 175 lbs. per sq. in. and then exploded, as in the usual method. This engine is double-acting, and receives a charge each side of the piston; thus two impulses are received each revolution, in a manner precisely similar to that of a steam engine.

Whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater complication of details in the two-cycle types, as compared with the simpler four-cycle engine, will cause the latter to continue to give the greater satisfaction, at least for the smaller sizes.

At the last meeting of the British Association, Mr. H. A. Humphrey gave some interesting data concerning recent gas engines, and the record is both remarkable and significant. The limiting size has rapidly grown during the past two years, as shown by the fact that one manufacturer is now constructing a gas engine of 2,500 H.P., and is prepared to build up to 5,000 H.P.

The development of the large gas engine is closely connected with the evolution of the fuel gas processes, and it is noteworthy that the first gas engines in England above 400 H.P. were operated with producer gas, while many of the large gas engines in Europe have been built for use with blast furnace gas.

In August of this year (1902) two leading English manufacturers had delivered, or had under construction, over 50 gas engines, varying in size between 200 and 1,000 H.P.; but we have to look across the Channel for still greater achievements in this direction.

Neglecting all engines below 200 H.P., we note that a classified list of gas engines in use, or under construction, shows the remarkable total of 327 gas engines, capable of supplying 182,000 H.P. This gives an average of about 560 H.P. per engine.

As compared with this, we find from the last U.S Census Report that, during the census year 1899, there were constructed in the United States 18,500 combustion engines, having a total capacity of 165,000 H.P., or only about 9 H.P. per engine.

Although this country has lagged somewhat behind Europe in adopting large gas engines, there is evidence that this state of affairs will not exist very long, for a number of enterprising firms are already in the field prepared to build gas engines up to any required size. One firm has already sold over 40,000 H.P. of large engines, most of them of 2,000 H.P., and several of 1,000 H.P. Another firm has recently built two 4,000-H.P. gas compressors, and also a number of 1,000-H.P. gas engines.

The use to which these large engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution; the tabulated list compiled by Mr. Humphrey for engines of more than 200 H.P. shows 99,000 H.P. for driving dynamos for light and power, and 83,000 H.P. for other purposes.

While the gas engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use the gas engines direct as motors.

A number of railroad and other machine shops have been equipped with moderate-sized gas engines suitably located about the works, and in addition thousands of horse-power are used in the smaller sizes for a wide variety of purposes, including village water-works, isolated lighting stations, and manufacturing plants of all kinds.

With the possibilities of high thermal efficiencies, we may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas engine into very general succession to the electric motor for many purposes, for it will doubtless be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use will effect a material saving in the utilisation of power over any existing methods.

It is not to be presumed that the gas engine will displace either the electric motor or the steam engine; each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas engine will be extended more and more into that of the steam engine and the electric motor.

Many of the questions involved in this consideration are at the present time in a transitional stage. The reciprocating steam

engine has reached a high state of development, but it is not probable that it has attained its highest degree of perfection. While an economy less than 9½ lbs. of steam per horse-power-hour has been obtained, even better results may be anticipated; the use of high-pressure superheated steam in compound, jacketed engines involves more perfect lubrication, and this may demand modification in existing valve types; however this may be, the outlook is promising for still higher efficiencies; whether this will mean cheaper power than can be obtained in other ways will depend upon many conditions.

In any case, and especially with intermittent or variable loads, it is not so much a question of maximum efficiency as it is economy of operation.

From this point of view the present activity in the construction and development of the steam turbine is of interest to engineers and power users. The steam consumption of a modern steam-turbine of moderate size compares very favourably with that of the better class of large reciprocating engines, but what is of greater importance is the evident superior steam economy under variable loads. The steam consumption per horse-power-hour varies little from one-third to full load; at over loads the economy, as shown by numerous tests, may be even better.

This feature predestines the steam turbine to the special field of electric lighting and power generation, where it must inevitably become a formidable rival of the larger-sized slow-speed reciprocating steam engine.

It is a significant fact that immediately following upon the installation of the large 8,000-H.P compound steam engines at the central station of the Manhattan Elevated Railway, New York, we find three 5,000-H.P. steam turbines under construction for the Rapid Transit Co., of New York.

The high-rotative speed of the steam turbine is a prominent factor in favour of its adoption in connection with electrical generators, since the cost of the generator end of the equipment ought eventually to be very materially reduced; but for many lines of work the high rotative speed of the present types of steam turbine is prohibitive, nor can it be adapted successfully to belt driving, except by the use of gearing. However, it is fair to presume that the present limitations of the steam turbine are not insuperable, and that the attention which is now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

The economies already obtained with both the steam turbine and the gas engine have brought each into a prominence which is at least suggestive of the important developments that are taking place in methods of obtaining and using power.

SOUTH AFRICAN NOTES.

[From Our Special Correspondent at Johannesburg.]

March 30th, 1903.

Ladysmith, Natal.—All the material has now arrived here for the telephone system between Ladysmith and Newcastle, Ladysmith and Dundee. Work will be commenced at once, and it is hoped to have the lines completed by the end of July. When these are finished it is hoped that a system connecting Newcastle and Dundee will be authorised.

Beaconsfield, near Kimberley.—The Town Council is considering an offer from De Beers for the electric lighting of the town.

Barberton, Transvaal.—As mentioned a few weeks ago, the Health Board of Barberton are considering the advisability of an installation of electric lighting for the town, and at a public meeting held this week it was unanimously decided to invite some firm or syndicate to undertake the work. A concession would be granted similar to the Bok-burg scheme, the Board reserving the right to appropriate the installation upon terms to be mutually agreed upon, and with a notice of six months.

Winburg, Orange River Colony.—Contractors have been busy for some time upon an installation of electric light for Winburg, and it is now all but completed. The system includes both public and private lighting, and it is hoped to switch on the current at the end of this month or early in April, in good time for our winter.

South African Association of Engineers.—At the monthly meeting of this association this week papers were read, and subsequently a discussion was held on, "The Modern Sanitation of Towns." One of the members advocated the adoption of artificial ventilation in preference to natural. He suggested that exhaustion by means of electric fans could be adopted to relieve the sewers of their gas, by dividing up the whole area to be drained into ventilating districts, such districts to have their terminal points at the greatest altitudes, where would be located ventilation chambers with electric fans, which would concentrate and draw off the gas from the district. By such a method the question of maintenance would be greatly simplified in comparison with the usual practice of having ventilators erected at every few yards along the mains.

Technical Education Commission.—A commission appointed to advise the Government is now inquiring into the best method of promoting technical education in the Transvaal. At the first public meeting of the committee this week, several gentlemen, who had had practical experience on the subject, were invited to give their views. The chief topics under discussion were, of course, mining and metallurgical subjects, and a high grade college was proposed for Johannesburg, with branches at different centres of the mining industry, where lectures would be given. At the Central College, both lecture and laboratory courses would be given, and in addition, instruction in general engineering subjects, particularly electrical engineering, would be arranged for. The principal aim of the college would be to provide for those students who have had a thorough grounding in the elementary grades, an advanced course where practical applications of their studies can be seen on the spot. A special feature would be evening classes for those at work in the mines during the day. Needless to say, this will be a great boon, and strong support is anticipated. Much comment was made on the fact that there are no qualifications to be obtained here as at home, and it was emphasised that standards similar to those at home should be established at once.

Pietermaritzburg, Natal.—At a public meeting here this week, convened for the purpose of discussing the tramway scheme, the Council were called upon to show why they persisted in their intention to take the tramways over a certain route in the face of public opposition, and before other suburbs already residential were served. The suburb in question consists of certain town lands recently acquired by the municipality, and is variously known as "Out span No. 6," "Foxhill," and "Scottesville." As yet no plots had been sold to the public, and it was at present valued at £100 per acre, whereas, besides being a desirable suburb, the value of the land would be immediately doubled by the promise of electric trams, and would enable the Council to serve the other suburbs shortly afterwards. After much discussion, and not a little heat, the action of the Council was confirmed.

On "South African Trade" and "Foreign Competition."—As is well known, Mr. Birchenough, special commissioner to the Board of Trade, was dispatched to South Africa about two months ago to collect information upon commercial questions with a view to assisting home manufacturers as far as is possible by a Government department. A representative of the *Rand Daily Mail* waited upon him this week to ascertain with what success he had so far met. Commencing at the Cape, Mr. Birchenough visited Bloemfontein, Pretoria, Delagoa Bay, and also the country districts in the Orange River Colony and Transvaal. Here, on the Rand, he naturally found, as did Mr. Morgan, his chief field of action, and has throughout received valuable assistance from Government departments, public bodies and the leading business houses and firms. With regard to the final object of his mission, that of establishing regular sources of supply of technical and commercial information for the Board of Trade in the principal centres, he has already made such arrangements for Johannesburg, and is engaged in establishing others in both mining and agricultural districts.

Speaking on that all-important topic, foreign competition, Mr. Birchenough says:—

"British trade is on the whole, I think, holding its own in these colonies, but I have found weak places, especially with regard to certain branches of engineering, where the Americans hold an advantage. British manufacturers, in my opinion, have hardly kept abreast of the advance in the application of electrical science.

"In the majority of trades they are doing all that could be expected, especially in soft goods, but when you come to engineering where competition is exceedingly keen in a market requiring the finest machinery and engineering goods the world can produce, there are weak points which should command serious attention at home. I refer, in a great measure, as I have said, to electrical engineering, and also to steel structural work."

"Competition," he went on to say, "is largely centred upon a few important branches, with regard to America, whereas Germany nibbles at nearly everything. America, as one expects, is our most formidable rival mainly in connection with machinery and produce. German opposition is not very serious in its character except in one or two lines, notably in electrical engineering. In short, British manufacturers need not fear Germany if they only exercise proper business enterprise. One thing British manufacturers must recognise is this: the attention of all the greatest producers of machinery in the world is concentrated on this market. Competition will be exceedingly keen in respect of engineering industries, and home manufacturers will have to exercise energy and enterprise if they are to continue to occupy the position they at present hold.

"There appears to be a decided inclination to give orders to British firms. But I discovered various defects in home methods of doing business; one great complaint, for instance, is that of slow delivery."

On the other hand, he said: "I am convinced that a great change has taken place, and the British manufacturers are showing themselves more alive to the general wants. Still I am doubtful if the firms at home fully realise the immense future of the Transvaal market. I don't fancy that they realise that beneath the manœuvres of the Stock Exchange lies perhaps one of the largest, most important and solid markets of the world. Many still regard gold mining as a speculation and not an industry. They are, therefore, in my opinion, devoting themselves to a market which is reaching the limits of expansion, and neglect to a great extent a market like this which is only at its beginning. With a settlement of the labour difficulty there is an immense expansion of trade possible in the Transvaal.

"Bounties given by Foreign Governments do not, I find, seriously affect competition. The Germans are very much helped by the low railway rates in their country, and American trade has been enormously aided by the low freights of the Conference lines. On this latter point I shall have some strong criticism to offer." He also finds that the British Colonies, principally Australia and Canada, are displaying great enterprise, and an eagerness to obtain a good footing in the South African market.

In conclusion, Mr. Birchenough remarked: "As I have said, the Transvaal offers an immense field for Imperial and Colonial manufactures and produce. Given the prejudice in their favour, which undoubtedly exists, manufacturers have only to exercise proper enterprise and alertness to keep the 'lion's share' of the

trade. But they must cultivate the market in the same way as they have cultivated the older markets."

Following the excellent report of Mr. Morgan, and concurring with it in the main, Mr. Birchenough's report should convince the home manufacturers that they will have to display more energy, and be prepared to meet their South African customers more than half-way if they mean to keep the "lion's share"; then with Australia and Canada each taking their "cub's share," there will be a mighty poor showing for the hyaenas.

Pietermaritzburg.—Mr. Dawbarn (of Mordey & Dawbarn) recently appeared before the Council to answer questions respecting the electric lighting and tramway scheme. In reply to some remarks about the eight-wheel cars specified, Mr. Dawbarn said that as to the suggestion of a longitudinal division of the cars, it appeared to him to be a practicable way of dealing with the question, although he had not seen the suggestion before. In providing a native compartment, the great point to be remembered was that it was dangerous to allow passengers to get on and off at the front of the car. He thought it would be possible on the lines suggested by Councillor Lindup to divide the car from end to end, leaving 3 ft. with one row of seats for the natives, and 4 ft. with two rows of seats for the Europeans. Then it would be quite feasible to make a division on the platform, so that the natives could have one entrance and the whites another. The Johannesburg scheme was a sufficiently large one to enable them to deal with the native question on its own merits, and entirely separate cars would be provided. He quite agreed with the lines that the Maritzburg Council intended to adopt in having one car to accommodate black and white passengers instead of having a trailer car, which would involve considerable additional expense. They would be always dragging the trailer car about, whether or not the requirements of the traffic demanded it.

General Electric Power Co. — This company's third ordinary general meeting was held at Johannesburg the other day, Mr. R. G. Fricker presiding. Though the operations for 1902 were not regarded as entirely satisfactory, they had been able to reduce the debit of the profit and loss account by the amount of profit for the year, viz., £2,802, thus still leaving a balance of £1,520 on the wrong side. Primarily the company was not created as a profit-earning venture, but as a means of supplying electric power to the numerous mines in the neighbourhood of Germiston under the control of the Consolidated Gold Fields of South Africa at the least possible rate consistent with the operations. This policy the company has so far carried out, and although its efforts have been neutralised to a considerable extent by the closing down of so many mines which would otherwise have been its customers, yet it had fulfilled the mission for which it was started. During the year the business had shown a considerable increase over that of the year before. It had lost the revenue derived from providing power to the military hospitals and camps in the neighbourhood, but some increased revenue had accrued from the adjoining village of Germiston. At present they had a very small demand for day-load from the works; by far the larger proportion of the supply was for electric lighting. As more work is undertaken on the mines, the demand for power in the daytime will be increased, which should materially lessen the current costs. The issued capital had increased by £10,000 to £145,000 during the past year, by the calling up of 1s. per share of the unpaid capital due by the shareholders, An uncalled balance of £55,000 still remained with which to meet the demands for future increase of plant. The company, said the chairman, should have a prosperous future in front of it, even supposing it could only find consumers for the power which it was generating, but as the use of electrical power was growing day by day, and the machinery by which it was obtained was being improved and perfected to a considerable degree, there was no doubt that when the industry had resumed its normal condition, they would find that even with a considerable increase of plant, the demand would prove greater than the supply.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Integrator" writes:—"I should be greatly obliged if your legal contributor could give me some information on the following:—I am employed by a company, which manufactures, amongst other things, meters. (1) Has the company any right over a patent for a new meter which I may take out? (2) If I leave the company's service and then take out the patent, have they any claim? I am assuming that the patent would be a new one, and not an improvement on that of the company's make."

*** No hard and fast rule can be laid down as to whether the inventions of a workman are his property or the property of his employer, but in Heald's case (5 R.P.C., 430) a workman was held entitled to have a patent sealed in his own favour although the company in whose employment he was contended that his discovery had been made while occupied upon their business. It is to be observed, however, that suggestions made by a workman employed in making a model for the inventor cannot be patented by that workman but, in fact, belong to the employer and merge in his invention. Hence he is the only person entitled to a patent for them. Therefore improvements in details suggested by such workman and embodied in the machine do not entitle that workman to oppose and stop the master's patent, on the ground that material parts of the invention have been obtained from him (David v. Woodley Griff, A.P.C., 26). At the same time inventions found out by a workman while engaged in his master's employment do not necessarily, by virtue of that employment, belong to the master. It is really a question of fact in each case.

In view of the above statement of the law, it is conceived that as "Integrator" has made the discovery in question independently of his employers, they can have no claim against him either before or after the date when he leaves their service.

"Three-Phase" writes: "Could you kindly inform me (1) The text of the Act as regards transmission of high-tension currents on bare conductors carried on poles across country, and if permission could be obtained to erect 5 miles of cable on the overhead system, at a pressure of, say, 10,000 volts three-phase, in the West of Ireland for the development of a water-power scheme; (2) The best manner in which to set about obtaining a provisional order, and whether the Corporation have to be consulted on the matter?"

*** "Three-Phase" should consult the regulations prescribed by the Board of Trade under Sec. 4 of the Electric Lighting Act, 1888, a copy of which can be obtained from Messrs. Eyre & Spottiswoode, London, E.C. These regulations were passed in order to bring under the control of the Board of Trade existing lines and works for supplying electricity which have been laid down without licence or provisional order, or special Act, and which were thus free of such control. The section above referred to provides that where in any case any electric line or other work may have been laid down or erected in, over, along, across, or under any street for the purpose of supplying electricity in such a manner as not to be enclosed in any building or buildings . . . . *or* where any electric line or work so laid down or erected may be used for such purpose otherwise than under, and subject to, the provisions of a licence, order, or special Act, the Board of Trade may, if they think fit, by notice in writing to be served upon the person owning or using, or entitled to use, such electric line or work, require that such electric line or work shall be continued and used only in accordance with the Board of Trade regulations. The regulations which seem to bear most nearly upon "Three-Phase's" inquiry are—"(4) The pressure between any two conductors, or between any part of either conductor and the earth, shall not exceed 3,000 volts; (10) Every high pressure conductor laid or erected *in any street* after the date of these regulations shall be continuously covered with insulating material. . . . . In cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches, or parts of an inch, than the number obtained by dividing the number expressing the volts by 20,000; (*Note.*—This regulation as to insulation appears to apply only where the cable crosses a street;) (14) No high pressure electric line shall be used for the transmission of more than 100,000 watts, or, in the case of an aerial line, 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be taken to prevent this limit at any time being exceeded." There are a number of other regulations which should be carefully studied by "Three-Phase" before he decides to proceed with his scheme.

[Special regulations are made in such cases as this by the Board of Trade, to whom "Three-Phase" should apply for information.—Eds.]

2. As to obtaining a provisional order, should "Three-Phase" have the file of the Electrical Review in his possession, he will find a useful article upon this subject in the issue of July 25th, 1902, at page 166.

THE CASE FOR THE MUNICIPAL TRADING COMMITTEE.

The Joint Committee on Municipal Trading having been re-appointed, it behoves all interested in this most important question to see that the case, which has been well commenced, is made as complete as possible; it would have been scandalous if the tactics of the Socialist party had prevailed, and the work already begun by the Committee had been left unfinished.

The Committee have to deal with both the theoretical and the practical sides of the question, and it will be useful to refer to the evidence already given in order to see how the matter was left when the proceedings terminated in 1900.

Theoretically, the Socialists advocate the concentration of all trade in the municipalities and the consequent abolition of private enterprise, but probably few actually go to this length.

In the case put forward by the local authorities it was argued that it was neither desirable nor possible to fix any limit to municipal trading, nor to lay down any general principle, and that every case must be judged on its own merits; but these views were not by any means adopted with unanimity, some of the advocates of municipal trading limiting it to such undertakings as constitute monopolies

—which are absolutely necessary to all the inhabitants—and which interfere with the streets.

Another section of witnesses did not object to the trading if carried on without profit, while others, taking what they consider to be a practical course, would prohibit any extension of the system, while allowing existing arrangements to go on.

With regard to the last proposal, it would be a very difficult, if not an impossible, course, to do otherwise than let things remain as they are, as a transfer to private companies of all the water, gas, electric lighting, and tramway undertakings at present in the hands of municipalities would be impracticable.

The contest will therefore centre in the limitation of municipal trading in the future, and upon this point the representatives of the municipal and anti-municipal traders will, no doubt, concentrate their efforts.

The respective leaders of the case will doubtless be the Association of Municipal Corporations and the sections of the Chambers of Commerce, which have already taken an active part in the discussion, but there is much need of a Municipal Reform Association which will combine all the trading interests threatened by the vigorous efforts of the Socialist Democratic Federation, Socialist Labour organisations and others which aim at the transfer of all trade to labour-elected local authorities.

It is most important that the general principles involved in the question should be very definitely stated, and it has been suggested that these should be framed by a committee appointed by the Association of Chambers of Commerce, assisted by a professor of political economy, and that such declaration be presented to the committee at their first sitting and endorsed by one or two witnesses possessing the confidence of the public.

Practical suggestions will naturally aim at what can be accomplished in preventing any extension of the trading already undertaken by municipalities, and in facilitating arrangements for turning over to private enterprise such existing business as is proved to be a burden on the ratepayers, and can be practically disposed of.

We have dealt so far with the principles underlying all municipal trading, but in the special case of the electrical industry it is necessary to bring prominently before the committee the unsoundness of the arguments and the misstatement of facts put forward by the municipalities in support of their claims.

The contention that municipal trading is justifiable in the provision of an absolute necessity, as is undoubtedly the case of water, with which every inhabitant must be provided, cannot be claimed for electricity supply, nor can it be considered as a monopoly, for it is in competition with other methods of obtaining light, power and heat, besides the fact of there being no legal prohibition to competing supplies of electricity.

Then, with regard to the use of the streets, there need be no greater interference by private companies, than if the disturbance were in the hands of local authorities; in fact, great inconvenience has often been experienced by the public in London thoroughfares, by the various local authorities repairing streets in their respective localities at the same time, which could have been prevented by arrangements between them as to the rotation in which the works were undertaken; apart from this, under the Electric Lighting Acts, the re-instatement of roads can be, and usually is, undertaken by the municipalities and the expense charged to the companies.

The necessity for disturbance of the roads is the same, whether the supply of electricity is given by the municipality or by a private company.

The local authorities contended that their trading in electricity supply had been successful, and was, therefore, justified, but the evidence adduced by them was of a most incomplete and unsatisfactory character, and should be met by evidence as to the results shown on careful analysis of the published accounts.

The want of proper accounts, based upon sound commercial principles and certified by independent Government auditors, should be pressed upon the Committee, and instances given of the character of those rendered by many municipalities, which show an apparent profit, while the undertakings really result in heavy losses.

The difference in the methods of accountancy adopted by one local authority and another should be illustrated by reference to the systems respectively adopted, especially in the provision for depreciation and antiquation of plant, change of systems of supply and machinery. It should be proved that the increased indebtedness of the municipal bodies, which is creating so much alarm, is not accompanied by a corresponding improvement in the value of the assets represented by the various loans.

The local authorities claim that the sinking fund covers all contingencies, and this contention should be exhaustively disproved.

The published accounts of municipalities do not enable the public to grasp the actual position, and experts from the Local Government Board could, no doubt, supply information to the Committee as to the amount of loans, date when the money was borrowed, amount to be annually set aside for repayment, original cost of land, buildings, and plant, and their actual value at the dates of the annual accounts.

It should also be shown where maintenance and renewal of plant have been provided for otherwise than out of revenue, and by applying the proceeds of new loans for the purpose.

The Committee should be asked to recommend a uniform system of accounts, and in any case to assimilate the Board of Trade form for both local authorities and companies, so that depreciation shall be provided for by the former as well as the latter, and a Government audit apply in both cases.

As to whether profits are or are not to be made by municipalities in their trading operations, the question of principle remains; but it will nevertheless be of importance to prove that, so far as electricity supply is concerned, results have shown that it is not a business for local authorities to speculate in at the ratepayers' risk.

The question of limitation of the borrowing powers of local authorities will form part of the inquiry by the Committee, as it is related to municipal trading, but in the meantime the Government might take action for stopping the raising of money without the consent of the ratepayers, as in the case of overdrafts from bankers in anticipation of the rates.

The drying-up of resources due to the late war, with its adverse effect upon business, coupled with the increase in local rates notwithstanding the growth of the rateable value in large towns, is arousing many ratepayers from the apathy which has caused so much neglect of their public duties, and it is being more fully realised that in connection with municipal trading the investing public, being less interested in it than in private enterprise, has sent money abroad which might have been employed at home in fostering private enterprise and maintaining the commercial prosperity of the country.

THE COOPER HEWITT INTERRUPTER IN WIRELESS TELEGRAPHY.

Each advance in wireless telegraphy has emphasised the inefficiency of the spark-gap interrupter, and this element has threatened to be the weak factor in the commercial development of aerial transmission. In the Marconi trans-Atlantic experiments the power required at the disruptive gap was enormous in comparison with the presumable quantity of energy radiated from the antennæ, and a serious incident of the great local disturbance thereby set up has been the adverse effect on telephonic service over a wide range, which forecasts trouble for the exploiters of commercial wireless telegraphy. It is, therefore, a matter of unusual interest to learn that an interrupter for an oscillating circuit has recently been devised which not only very greatly reduces the draught on the source of electrical energy, but possesses most valuable properties with respect to exact control, and at the same time is extremely simple in form and application.

In wireless telegraphy the spark-gap oscillating circuit has heretofore been employed, in connection with either the simple induction coil or the disruptive gap. In his studies on the mercury vapour tube, it occurred to Mr. Peter Cooper Hewitt that the "electric valve" property of the vapour tube, which he has employed in his static converter, could be applied to the oscillating circuit. This application he has succeeded in carrying out in a most successful manner.

Briefly stated, the spark-gap of the oscillating circuit is replaced by a mercury vapour tube in parallel with a condenser. Assuming

that the immediate source of electrical energy is a transformer, in the transformer secondary in series are a condenser and the primary of the antennæ-ground circuit, the condenser being shunted by a vapour tube. The tube does not differ in principle from the usual Cooper Hewitt vapour tube, though naturally it is of a somewhat different form, owing to its different application, and the nature of the work to be performed. The transformer secondary voltage may range between 10,000 and 20,000 volts.

The fundamental advantage of this interrupter is the enormous speed of interruption that may be attained, and the absolute control of this speed. Moreover, by proper design and adjustment, any given rate of adjustment can be secured. With the disruptive spark there is a limit to the efficient rate of interruption fixed by the time required for the condenser to clear itself, and this rate, as well as the total effect, is variable, owing to the mobility of the arc, the condition of the knobs with respect to polish, &c. The latter consideration does not apply to the mercury electrode surface, and the vacuum discharge is not subject to similar fluctuations. It follows that with this new type of interrupter it is possible to create and maintain continuously oscillations of an absolutely definite character, the great importance of which consideration with respect to wireless telegraphy is obvious.

The practical advantages of the interrupter are no less evident. The efficiency is very high, the loss being about proportional to the drop of about 14 volts in the tube, and in a circuit of 10,000 volts this amounts to but a small fraction of 1 per cent. The device, consisting merely of a glass tube or bulb with sealed-in electrodes, is inexpensive, and in case of breakage can be immediately replaced by another in the same manner as an incandescent lamp.—*Electrical World.*

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

7,899. "Improvements in or relating to prepayment electric meters." The British Westinghouse Electric & Manufacturing Co., Ltd. (G. G. Tilden, United States.) April 6th.

7,900. "Improvements in sliding contacts to maintain continuous connection in supplying electrical currents to cranes, locomotives and the like." C. Henson and S. D. Brown. April 6th.

7,906. "Telegraphic apparatus automatically composing the telegraphic signs." F. Saldana. April 6th.

7,910. "Improvements in or connected with apparatus for automatically operating the track and conductor switch points of electric tramway systems." J. Hartley and J. Greenwood. April 6th.

7,930. "A new or improved clip for electric wiring purposes." W. C. Johnson. April 6th.

7,955. "Improvements in electric couplings." J. N. Dauncey. April 6th.

7,960. "Improvements in electric pumps." G. B. Ellis. (The Automatic Electric Pump Co., United States.) April 6th.

7,965. "Improvements in telephonic apparatus." A. Graham. April 6th.

7,977. "Improvements in and relating to electric switch operating mechanism." S. Z. de Ferranti. April 6th.

7,980. "Improvements in self-registering electrically-operated sectional targets." G. A. Peters. April 6th. (Complete.)

7,988. "Improvements in or connected with the electrical insulation of metal pieces." W. J. Davy. April 6th.

8,010. "Improvements in and relating to an electric push contact device." W. G. Heys. (The Richmond Electric Manufacturing Co., United States.) April 7th. (Complete.)

8,018. "Improvements in induction motors." A. L. Cushman. April 7th. (Complete.)

8,021. "Improvements in induction motors." A. L. Cushman. April 7th. (Complete).

8,022. "Improvements in open or enclosed arc lamps." J. F. Wakelin, W. Burns and C. J. Weston. April 7th.

8,025. "Swan electric lamp fitting with transversely arranged plug sleeves for connection with the spring terminals." F. Schröder. April 7th.

8,028. "Improvements in or relating to the arrangement and construction of electric arc lamps." C. Oliver. April 7th.

8,054. "Improvements in brushes for electric machines." M. A. McLean. April 7th.

8,056. "Improvements in or relating to incandescent electric lamps." A. J. Boult. (The American Miniature and Decorative Lamp Co., United States.) April 7th. (Complete).

8,108. "Adjustable electric light fitting." W. P. Adams. April 8th.

8,112. "New or improved automatic electric signalling apparatus." L. E. Harvey. April 8th.

8,145. "Improvements in or connected with pipes or troughs for containing electric conductors." H. P. Smith. April 8th.

8,195. "Improvements in electricity meters." L. Plesson. April 8th.

8,200. "Improvements in or in connection with current collectors for electric tramcars and other electrically-driven vehicles." H. Sheldon. April 8th.

8,229. "System of electrical operation." J. C. Slaughter. April 9th.

8,262. "An improved combined electric bell push and fire alarm." F. R. C. Joyce. April 9th.

8,279. "Improvements in electric switches." T. von Zweigbergk. April 9th.

8,280. "Improvements in electric switches." T. von Zweigbergk. April 9th.

8,304. "An improvement in or connected with switches for controlling the distribution of electricity." J. E. Spagnoletti. April 9th.

8,321. "Improvements in and relating to safety devices, applicable to electric cars and the like." M. Heinrich, E. Heinrich and R. Prozger. April 9th. (Complete.)

8,322. "Improvements relating to motor-ampere-hour meters for various electric pressures." W. E. Evans. (Allgemeine Elektricitäts Gesellschaft, Germany.) April 9th. (Complete.)

8,380. "Improvements in or connected with fusible electric cut-outs." H. F. J. Thompson. April 11th.

8,389. "Improvements in electric accumulators." R. Traub & Co., Ltd. (Date applied for under Patents Act, 1901, April 19th, 1902, being date of application in Switzerland.) April 11th. (Complete.)

PUBLISHED SPECIFICATIONS, 1902.

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14,293. "Improvements relating to the control of the speed of electric motors." H. H. Lake. (General Electric Co.) Dated June 24th.

15,049. "Improvements relating to telephone switches." J. B. Birnbaum. Dated July 5th.

17,396. "Improved receiver for use in wireless telegraphy and telephony." La Compagnie Française des Télégraphes et Téléphones sans Fil. Dated August 7th.

17,548. "Electric heater and rheostats." G. P. Wisdom.

17,811. "Improvements in insulating apparatus for electric currents of high tension." K. S. Lemström. Dated August 13th.

17,867. "Moisture and waterproof fixture and guard for electrical attachments, such as incandescent lamps, plug attachments, and the like." A. F. Hauss. Dated August 14th.

17,953. "Improvements in marine electric light fixtures." G. L. Martin. Dated August 15th.

18,148. "Improvements in electrical fire alarm apparatus." J. P. Robertson. Dated August 18th.

18,465. "Improvements in electric lighting apparatus for automobiles and the like." V. Klement. Dated August 22nd.

19,180. "Improvements in electric baths." J. Zwiebel. Dated September 1st.

19,225. "Improvements in storage batteries." W. Fairweather. (The International Battery Co.) Dated September 2nd.

19,272. "Improvements in incandescent electric lamps." A. W. W. Miller. Dated September 2nd.

19,488. "An improved electrolytic electricity meter." J. Battle y Hernandez, E. Mier y Miura, Luis de la Pena and J. Benito y Ortega. Dated September 5th.

19,719. "Improvements in the composition of electrolytes for the formation of accumulator plates." E. Sandhagen and J. Lürgen. Dated September 9th.

20,289. "Improvements in telephone systems." D. Macadie. Dated September 17th.

20,461. "Improvements in detachable connections for use in electric lighting and heating." A. P. Lundberg and G. C. Lundberg. Dated September 19th.

20,553. "Improvements in electric switches." J. G. Waterman. Dated September 20th.

20,553. "Improvements in electro-magnetic valve controlling apparatus." J. G. Waterman. Dated September 20th.

20,555. "Improvements in electro-magnets." J. G. Waterman. Dated September 20th.

20,616. "Improvements in dynamo-electric machines." B. G. Lamme. Dated September 22nd.

20,684. "Improvements in perforating machines for preparing telegraphic messages for automatic transmission, applicable also to other, analogous apparatus." W. L. Wise. (C. L. Buckingham, U.S.A.) Dated September 22nd.

20,923. "Improvements in means for adjusting the height of suspended electric lamps." A. Huber. Dated September 25th.

20,970. "An improved electric insulator." H. Kerkmann. Dated September 26th.

21,782. "Improvements in telephone signalling systems." A. Ekström. Dated October 6th.

21,733. "Improvements in and relating to electric fans." J. C. Fell. (W. E. Coleman, U.S.A.) Dated October 6th.

21,748. "Improvements in arc lamps." F. S. Worsley. Dated October 6th.

21,771. "Improvements relating to electric rail or track bonds." W. R. Bowker. Dated October 7th.

21,855. "An improved electric indicator." D. Wells. Dated October 8th.

21,888. "Improvements in systems of electrical distribution." B. G. Lamme. Dated October 3rd.

21,914. "Improvements in and relating to the regulation of dynamo-electric machines." H. H. Lake. (General Electric Co., U.S.A.) Dated October 8th.

22,261. "Improvements relating to the method of and apparatus for armouring electric cables and the like, also applicable to the manufacture of flexible tubes." E. T. Greenfield. Dated October 13th.

22,280. "Improvements in conduit systems of electric railways and tramways." J. F. Smith. Dated October 13th.

22,356. "Improvements in retarding devices for use in connection with electrical measuring and like instruments." A. O. Benecke. Dated October 14th.

22,532. "Improvements in incandescent electric lamps." J. J. Rooney. Dated October 16th.

22,615. "Improvements in insulated connectors for electric cables." L. W. de Grave. Dated October 17th.

22,825. "Improvements in automatic switches for single-phase and polyphase traction transformers." A. Schlatter. Dated October 20th.

22,854. "Improvements in electric fuses." W. B. Dale. Dated October 21st.

23,742. "Improvements in dynamo-electric machines." D. Balachowsky and P. Caine. Dated October 30th.

23,753. "Improvements in and relating to telephones." J. B. Birnbaum and J. Berliner. Dated October 30th.

23,971. "Improvements in or relating to electric motors." O. H. Pieper. Dated November 3rd.

24,068. "Improvements relating to arc lamps." A. de Puydt. Dated November 4th.

24,099 "Improvements in or relating to alternating current generators." H. H. Lake. (General Electric Co.) Dated November 4th.

24,109. "Improvements in regulators for arc light systems." H. H. Lake. (General Incandescent Arc Light Co., U.S.A.) Dated November 4th.

24,459. "Automatic electrical cut-out." D. R. Bruce. Dated November 7th.

24,777. "Improved means for protecting the third rail in electric railways." H. Brooks. Dated November 11th.

25,511. "Improvements in carbon or brush-holders for dynamo-electric machines and the like." C. Zabel, B. Zabel and W. Zabel. Dated November 20th.